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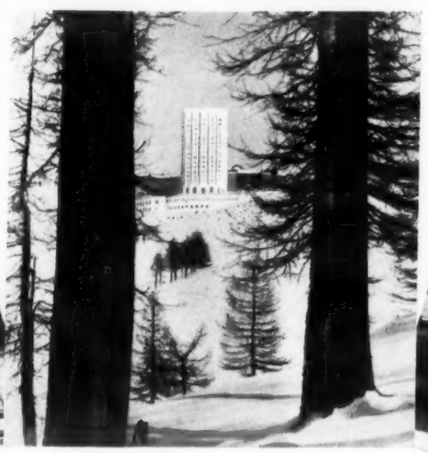

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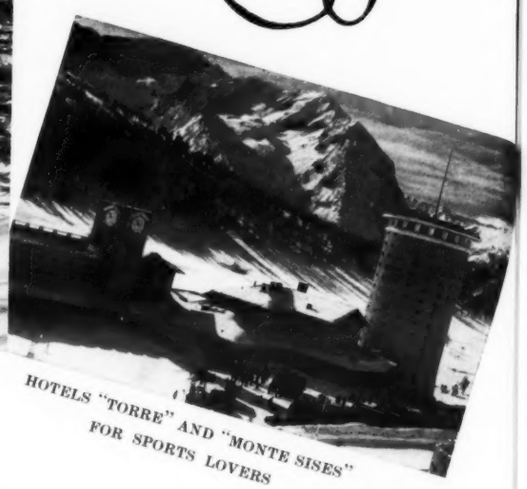

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INTERAVIA

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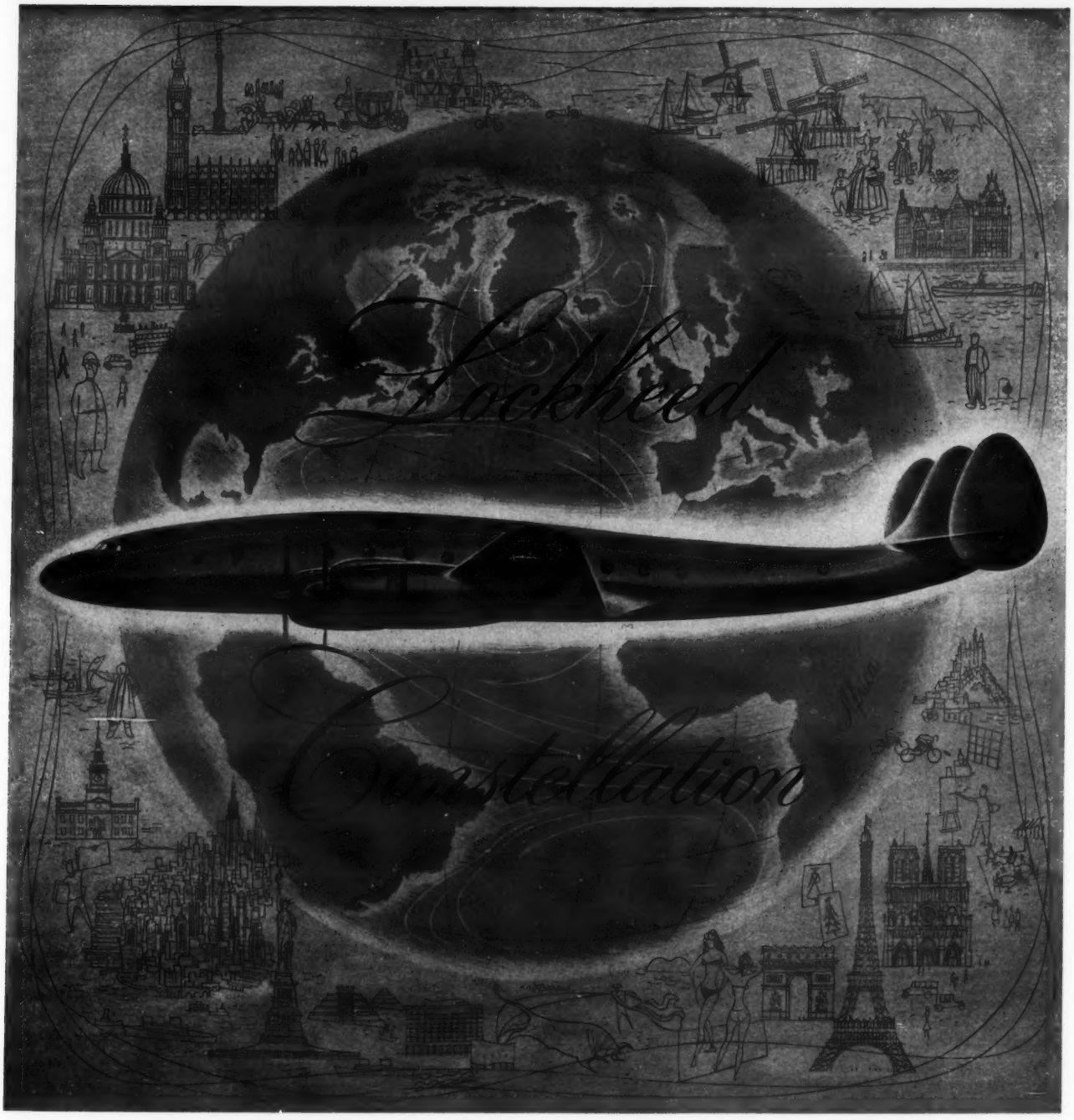

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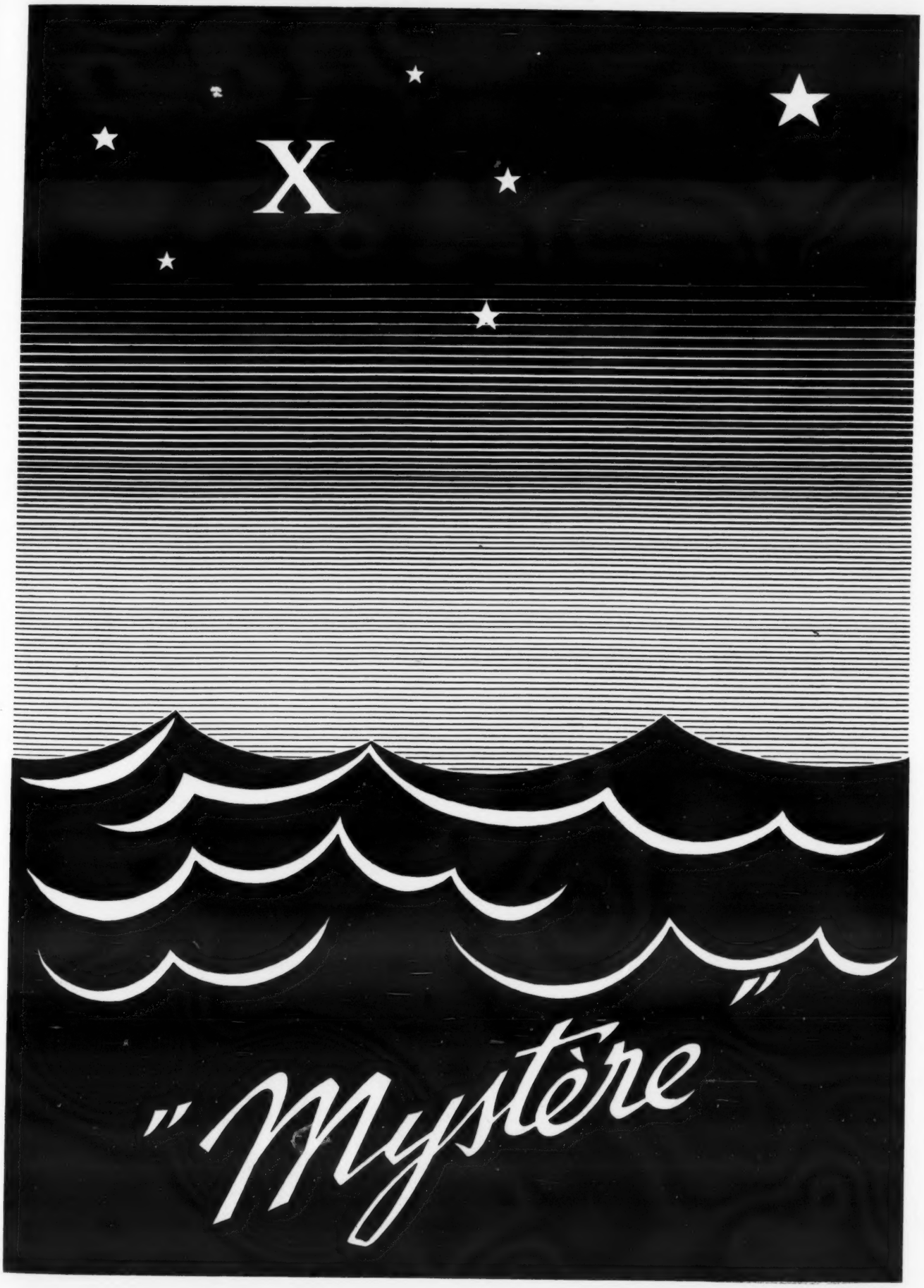
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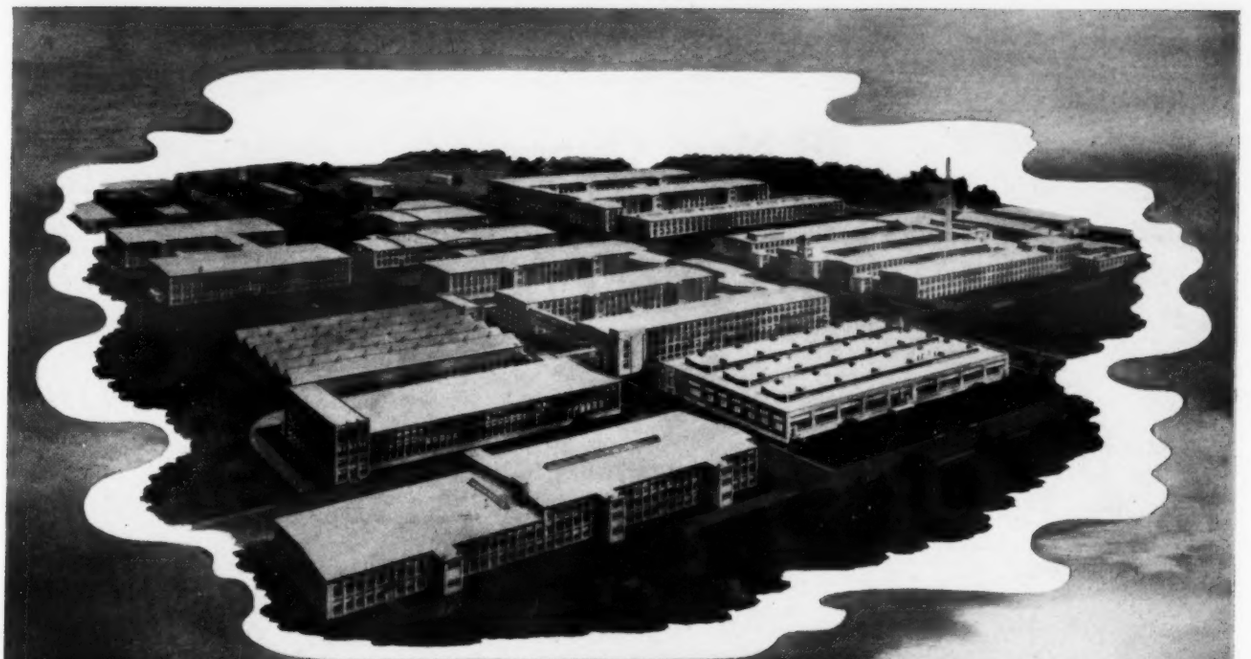

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150 Million Air Passengers Going Begging

Montreal, headquarters of the international civil aviation organisations, is a long way from Bonn; Washington, nerve centre of the American air transport system is no nearer and London is geographically and psychologically the capital of a powerful island.

The distance between Paris and the Capital of the West German Federal Republic is smaller. For example, "*Combat*," the Paris daily which is not without its importance in French politics, published an article on 1st January, 1951, by a well-known member of the French aviation world, writing under a *nom-de-plume*. The title is illuminating: "Taking a stand for the future... Ten air transport companies prepare the future rôle of German aviation". The present-day network of services over Germany is shown on a map, and the four-column article illustrates clearly the potential traffic volume offered by the 50 million inhabitants of industrial Western Germany. The writer warns his compatriots: "...Steps must be taken towards a wise preparation for the future. If we do not take them, someone else will. France still holds enough trumps to be able to negotiate successfully. But her present-day chances will inevitably disappear if more realistic rivals act faster."

If our information from Bonn is reliable, this French article is not likely to go unperceived in the West German Federal Republic.

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Aviation should not be underestimated, nor on the other hand should its rôle be overestimated. It is only a branch of transport, although admittedly one capable of great development and politically of the utmost importance. In the case of Germany this branch of transport has been more or less taboo during the last six years, since 1945... a subject that could barely be mentioned, since Germany possessed no sovereignty in the air. However, now that the High Commissioners, who meet regularly on the Petersberg, have begun—on instructions from their governments—to talk about German rearmament and are even said to have mentioned the word "tactical air force," there is no longer in the concept of German-operated air transport any hint of a breach of diplomatic good manners, *i.e.* in the present case the Occupation Statute.

This by the way.

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Air transport is, then, a branch of transport, and in Germany nothing is in such bad shape as transport. Here the repair of war damage has scarcely begun and it will be scores of years before everything that was destroyed by Allied bombs and berserk German SS troops can be restored. Another trouble is that co-ordination of the various branches of transport in Germany is by no means satisfactory.

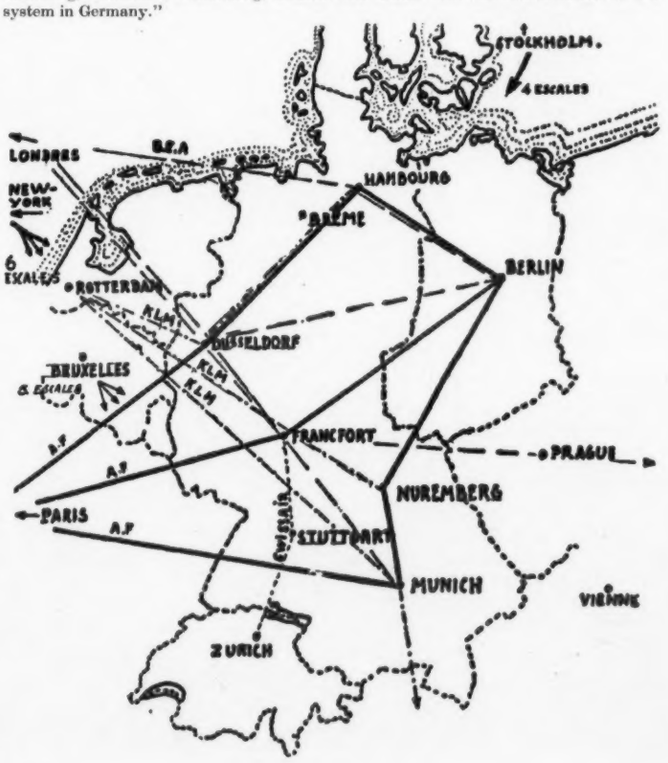
There is the Federal Railway, which is still said to represent a capital of roughly DM 25,000 million. On 28th December, 1950, a semi-official article appearing in the widely-circulated Hamburg weekly "*Die Zeit*" stated: "The railways must be made to pay again." A pious hope, seeing that their deficit for 1950 is estimated at a round DM 500 million. According to the Hamburg paper the railways get DM 0.05 per kilometre net, whereas unorganised road transport takes DM 0.10. The railways, however, carry 82% of German goods traffic but in 1950 took only DM 2,300,000,000 from it, whilst unorganised road transport, carrying only 18%, took a round thousand million. The extent to which such planning is uneconomic is also shown by the fact that the railways paid out roughly DM 320,000,000 for German-mined coal, while road vehicles spent DM 530,000,000 on fuel, of which DM 200,000,000 was in foreign currency.

Here is one of the roots of the trouble in the German transport system, with which Dr. Hans Christoph Seebohm, the Federal Transport Minister dealt in the "*Hamburger Tageszeitung*" on 30th December, 1950. He complains of the difficulty of the problem, but considers that progress is being made. He talks of railways, roads and inland waterways. This time he does not mention air transport, although he has previously pleaded for a German-controlled airtransport system.

Now one must not, of course, throw the baby away with the bathwater and lay all the blame on the failure of the international civil aviation organisations or on the negative attitude of the three High Commissioners. On the contrary: the Allies have done much to help German transport. For example, the Americans sent a committee of experts to Germany to assist in the reconstruction of the Federal Railways. On the German side, a new Federal Railway law has recently been introduced, and improvements are to be expected in this branch of transport.

The question therefore remains why nothing decisive has yet been done about German air transport. Certainly no blame can be attached to Chancellor Adenauer, for in spite of his many other preoccupations he has shown that the problem of air transport is close to his heart. The Federal Transport Minister, too, has a clear conscience, since he has repeatedly fought for a German air transport

The air transport network in Western Germany (from the French newspaper "Combat") has the following caption: "If all the West German lines were drawn in this map, none of them would be recognisable. We have therefore contented ourselves with indicating only the American, Scandinavian, Belgian and Yugoslav services which however represent only about half the air services over German. It will be seen that towns such as Hamburg, Frankfurt, Nuremberg, Munich and Berlin form the corner-stones of the system in Germany."



150 Million Air Passenger

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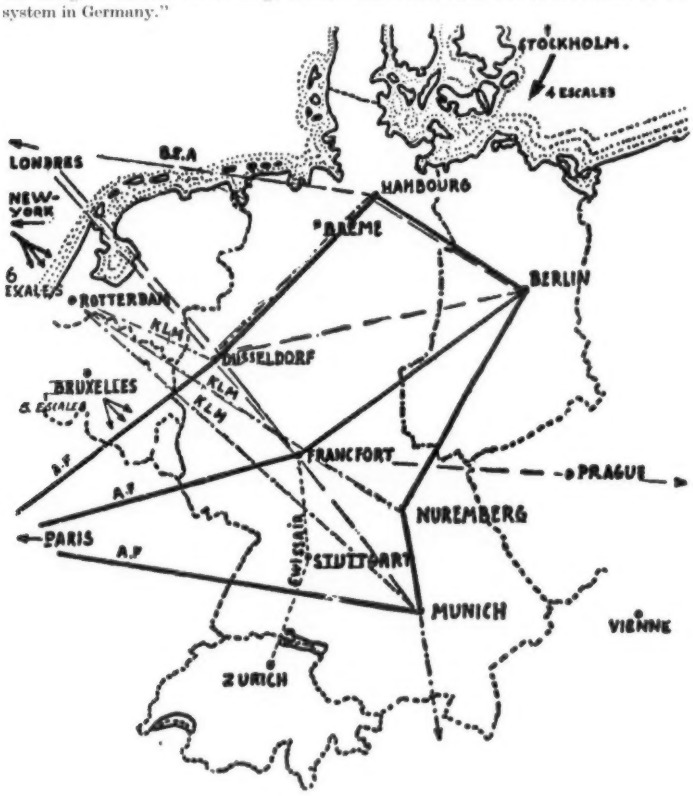


German railway travel in 1950... very modest.

German railway travel in 1951... A double-deck coach belonging to the Federal Railways, with every comfort.

system, so much so that he has earned the nickname "Luftbohm" ("Airbohm" instead of Seebohm). Where, then, does the reason for failure lie?

On the one hand in the somewhat short-sighted but in the circumstances excusable egoism of foreign companies which have been able to operate at will in the German air space. In 1949 and even more so in 1950 this air space became a profitable hunting ground for many, in particular for the ten companies mentioned in the article in "Combat"—though it should be pointed out that the French have so far taken but a small part in the chase.

On the other hand, the blame lies with the Germans themselves. A great number of associations have been formed, which have drawn up programmes, held meetings and favoured the High Commissioners with more or less intelligent memoranda. As there has been no man of calibre at the head of these associations, the former gifted men of the *Lufthansa* having disappeared, the value of these memoranda was more negative than anything. The Transport Minister on his side is not an air transport expert. Like every minister in every democracy he is a politician, and in private life an experienced industrialist. In democracies the minister is therefore given an Under-Secretary, who is an expert, to help and advise him. Under-Secretary Prof. Frohne of the Transport Ministry is a railway man. He is regarded as an expert on the construction of railway stations and is said to have been responsible for building the railway installations in the Greek town of Salonica. But just as one would not expect Mr. Trippe of Pan American Airways or Dr. Plesman of KLM to be shining lights in railway transport, the German Under-Secretary for Transport cannot be expected at his time of life to develop a full understanding of a subject such as air transport which has hitherto been a closed book to him. His heart belongs to the railway and its stations. At the end of the year it was announced that he would in future devote himself entirely to this sphere, which will no doubt be a good thing for the railways.

This raises the question of whom the Chancellor and his Transport Minister will entrust with the task of rebuilding German air transport. The choice of man for this post is an important one. The decision taken here will affect far more than German air transport. One might almost say that upon it depends the future of all air transport in Central Europe.

*

There are plenty of air services over Germany, but timetables and rates are not carefully adapted to German requirements. It is obvious that companies such as SAS, KLM and BEA, for example, cannot be expected to upset their whole timetables just to suit the convenience of the domestic German air transport market. For them the German side of the business is a side-line—but that this side-line is profitable is shown by the trouble it gives the Finance Minister. The latter has to find roughly DM 80 million, or $20 million a year, in foreign currency for foreign air transport over Germany, to pay the foreign companies their revenues from the German business. He can also reckon that these companies take at least another DM 100 million, which they use in their business and which are thus also more or less lost to the German economy. This means that the Transport Minister has a strong supporter in the Finance Minister —a very important man these days. Both would like to see air transport in Germany under German control.

Conditions in this West German Federal Republic cannot be measured by the same yardstick as in other countries. Imagine the following! You buy a ticket from a German travel agent or your hotel porter for a sleeper on an international train. Your train draws into the station and you find there are two sleeper coaches, one an international one, new and clean, belonging to the *Compagnie Internationale des Wagons-Lits*, and the other a German one, older and not quite so clean, belonging to *Mitropa*. Naturally your sleeper is in the old Mitropa coach, since the Federal Finance Minister has made sure that there shall be no invisible export of foreign currency through use of the international coach. Is it really likely that the same Finance Minister will continue to stand by and watch invisible exports in air transport? Apart from anything else, the High Commissioners would not permit this.

Another thing...

You are walking down the main street in a large German town. Suddenly you come upon a big, brightly lit show window, in the most central position. The travel agency of a foreign air transport company—and if it is the most handsome travel agency (bravo, Dr. Plesman!) it will belong to the KLM Royal Dutch Airlines. This company's organisation is in the lead in Germany today. It is exemplary and revealing. Revealing, because it betrays long-term planning.

The Dutch have doubtless argued on very logical lines, namely: we can no longer regard ourselves as a great colonial power. We are a tough, hard-working European nation of shopkeepers and exporters. But what can we export? Philips radio and electrical equipment, Bols gin, cheese, butter and eggs, cabbage and flower bulbs. This is not enough to replace our former colonial wealth. But there is another European people who have virtually nothing to export but herrings but who still manage to keep solvent year after year, the Norwegians, who built up the third-largest merchant marine in the world and became the sailors for the nations. We Dutch will build up the biggest air fleet in Europe and become the "sky carriers of Europe." Such most probably was the Dutch line of reasoning.

The year 1951 may see the return of German air sovereignty. At the moment Americans, Dutch, British, Scandinavians, Belgians, Swiss and many others are making their plans for air traffic within Germany. It would appear impossible for a country as weakened by the war as Germany to build up its own air transport without outside aid, and it is by no means certain that she is even thinking of doing so. The question therefore remains who is to be the partner who will play the decisive part in the resurrection of air services within and radiating from Germany. The Frenchman who signs himself "Philippe François," though this is not his real name, appeals to his Transport Minister, the President of Air France and to the common sense of the French people. A kind of Schuman Plan in the air? Such a plan would have many attractions.

France is in the fortunate position of being a wealthy country with a first-class network of overseas air lines, a renascent aircraft industry and close connections with Italian civil aviation. She could even resume old contacts with the former German air transport system. If France recognises this situation in time, she can build up a European air transport *bloc* of almost 150 million people and—quite apart from all questions of politics—this *bloc* could place the European air transport economy in that healthy position which all concerned so earnestly desire.

EEH.

The French Aircraft Industry Springs a Surprise:

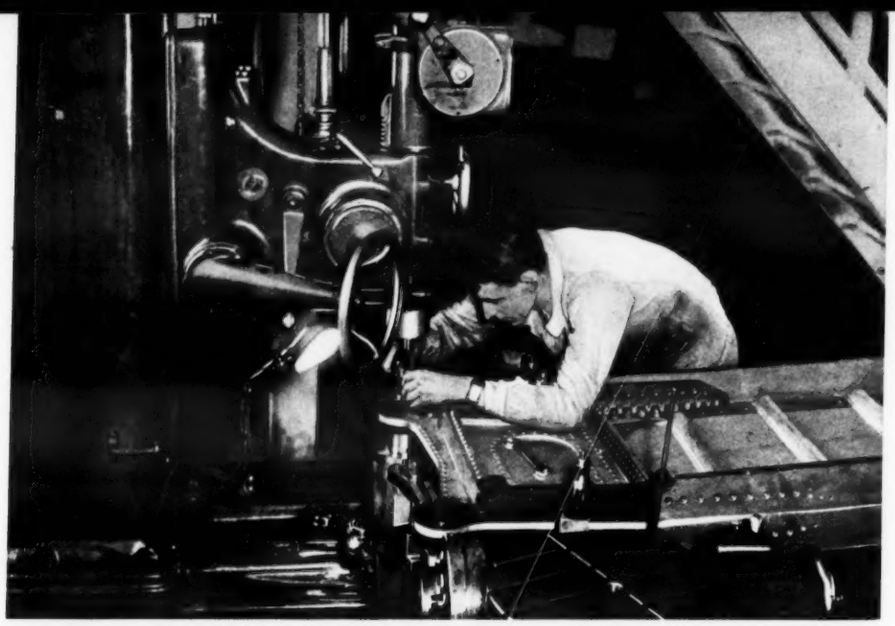
Producing the "Bretagne" Twin-Engined Commercial Transport

Air transport companies wishing to buy new aircraft for their medium range services in recent years have turned their gaze primarily to the American Convair 240 and Martin 2-0-2 twin-engined types, perhaps for a time to the Swedish "Scandia" and, on the British side, to the twin-engined Airspeed "Ambassador" and the four-engined Vickers "Viscount" propeller-turbine transport.

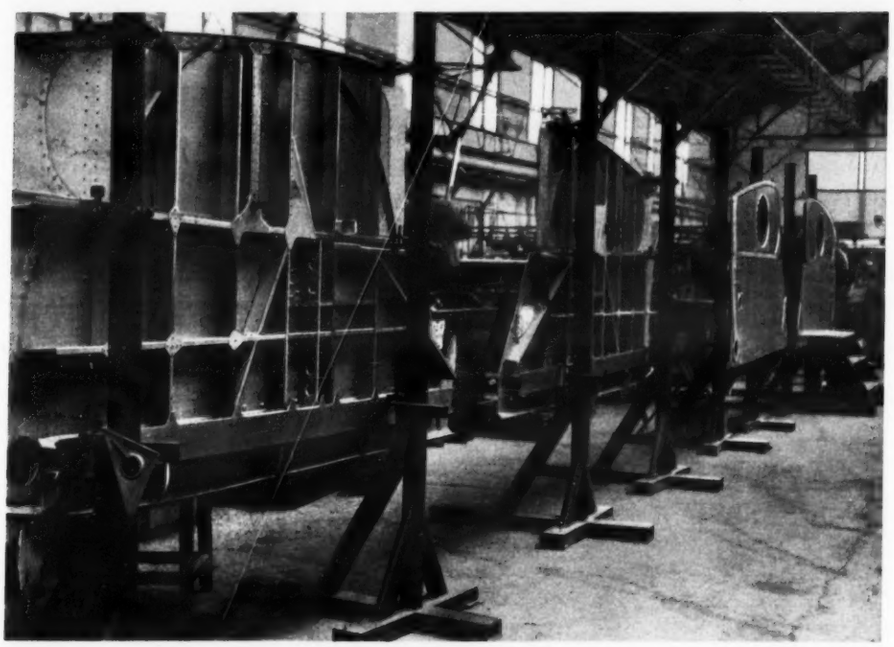
It was known, of course, that for some years, France had also been developing a twin-engined civil transport aircraft but it appeared to be suffering from teething troubles, which caused Air France to hesitate long before placing an order. Then too, the advertising campaign for the French type was not as successful or intensive as for the British and American models.

For Interavia readers the *French SO 30 design* is an old acquaintance. It was first mentioned under the name SO 30 R "Bellatrix," in August 1946 (cf. Interavia 1946, No. 5). At that time it was fitted with French SNECMA 14 R (Gnome Rhône) engines and had a single vertical tail unit. It was based on a design by engineer Parot and collaborators. This design dated from 1941,

Assembled fuselages for the SO 30 P at SNCA du Sud-Ouest's Saint-Nazaire main factory.



Drilling the connecting pieces on one of the wing centre section spars.



Riveting the rib for the main undercarriage to the centre section.

The stiffened box spars of the outer and inner wing sections being assembled.

and production was started even before the liberation of France. An order for 40 of these aircraft was placed in 1945.

In fulfilling this order the makers, *Société Nationale de Constructions Aéronautiques (SNCA) du Sud-Ouest*, had to face considerable difficulties. The original design was constantly being improved, to keep pace with technical progress in the equipment, the French Technical Service repeatedly issued fresh specifications, and Air France, the French national air transport company, was anxious that any aircraft it put into service should meet all its requirements without the need for modification.

Since the completion of the first model, which started flight tests at the official test centre at Brétigny in November, 1946, the SO30 has been subjected to a *great many modifications*. One of the major reasons was that the aircraft had to conform to ICAO regulations (Class A: flight on one engine), introduced since that date. The biggest external changes were the fitting of more powerful engines, namely, American Pratt & Whitney R-2800 "Double Wasps," and the replacement of the single fin and rudder by a double unit. In addition, the aircraft was given greatly improved and modernised equipment. However, modifications were limited to certain elements of the airframe. The old SO30R "Bellatrix" disappeared and *was replaced by today's SO30P "Bretagne,"* which is described in the technical section of this issue. The aircraft, after extensive tests, has now been certificated by the French technical services, has been sold in small numbers and is at present the subject of negotiations with Air France.

With a *pressurised cabin* for 30 to 43 passengers, for freight or mixed transport, the "Bretagne" has a good take-off, climb and speed performance. Depending on the type of R.2800 engine fitted (B.43 or CA.18) it can carry a useful load of from 3200 to 4000 kg (1000 to 8800 lbs.) over approx. 625 miles, or 2500 to 3300 kg (5500 to 7300 lbs.) over a distance of approx. 1000 miles.

Three branches of the SNCA du Sud-Ouest, situated in the south west of France, principally round the industrial town of Nantes and the harbour of Saint-Nazaire, are engaged in the production of this aircraft. About a dozen have been built and the rest are to follow shortly.

The outer wing sections, with integral fuel tanks, are made at *Bouguenais*, near Nantes, the tail unit parts come from the *Rochefort* works south of Nantes, fuselages and wing centre sections (as well as flaps, power plant parts and internal equipment) are produced

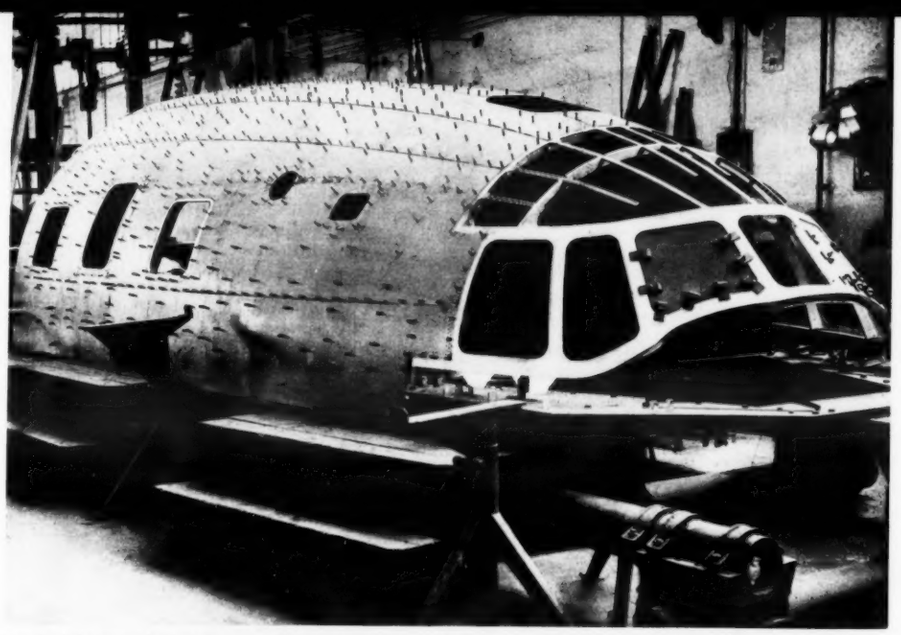
by the main works at *Saint-Nazaire*, where 1600 staff are employed. This factory, which has a built-up area of over 360,000 sq. ft., may be regarded as one of the best equipped in France. It is here, too, that the "Bretagne" is assembled. The finished aircraft are then taken by private road to nearby Montoir aerodrome and handed over to the test pilots.

Whether the production of the "Bretagne" is a paying proposition for the makers or the French government is an open question. No firm that has brought out twin-engined commercial transports during recent years has got rich on them, not even Convair or Martin. And as the French production engineer—like his American colleague—could say:— "Of course, forty transport aircraft is a nice little order... but you can't exactly call it mass production. We can't afford car production methods."

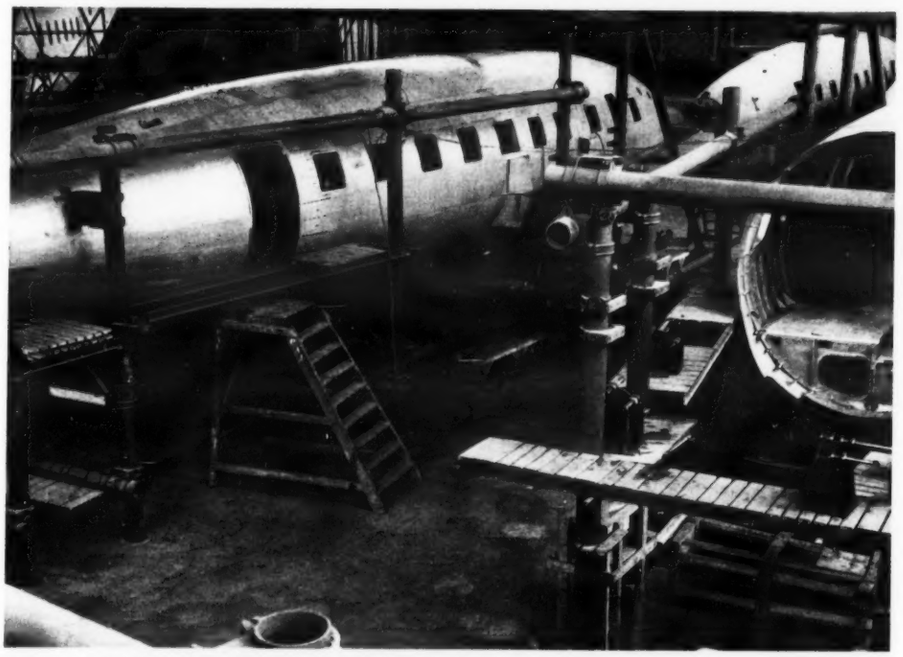
Our first series of pictures shows some details of the construction of the wing centre section at Saint-Nazaire, namely final treatment of the centre section spars on a highly accurate drilling machine, riveting of the supporting ribs for the main undercarriage in vertical jigs, connecting up the wing parts between the main spars. The wings, of stressed skin construction with two girders, are in two halves, each comprising the centre section box spar and the wing box spar, to which the various parts of the leading edge, ailerons, flaps, undercarriage doors and engine nacelles are attached.

The fuselage (second series of pictures) is built on two production lines. It consists of six basic parts:—lower half of nose with nose wheel well, upper half of nose with control cabin, centre section of fuselage, upper and lower rear ends of fuselage, and finally tail cone with pressure bulkhead. Each sub-assembly, as shown in the centre picture, is constructed in easily accessible frames. This ensures the high quality of riveting essential for a pressurised cabin. Finally the various parts of the fuselage are put together in two great tubular frameworks (bottom picture).

As is customary in modern aircraft construction, all jigs consist of standard parts which can later be used for other aircraft types. The production engineer describes these frames as "invisible reserves." "At one time," he added, "the jigs were simply thrown on the scrap heap when the production series was finished."

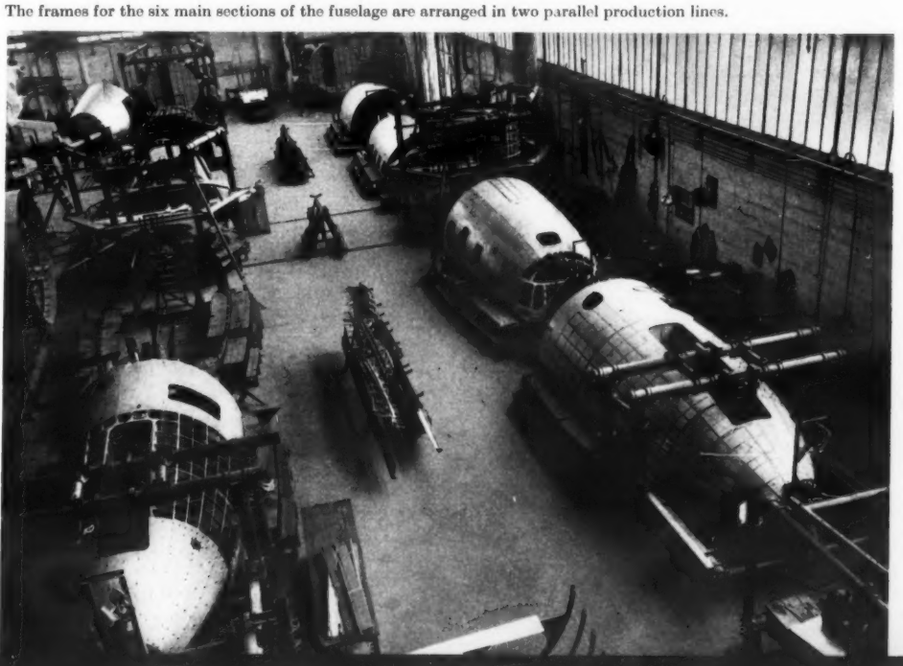


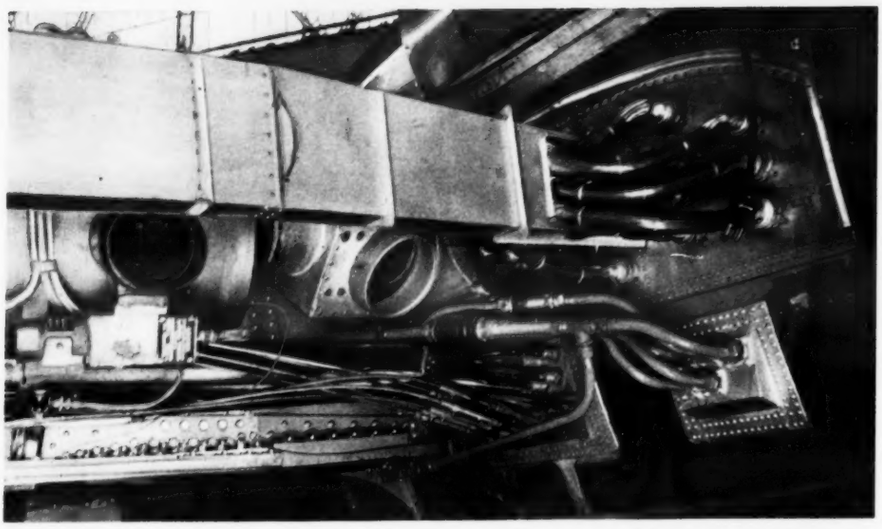
Detail of the upper half of the nose. The windscreen frame is made of a welded light metal alloy (Duralinox)



The two assembly frames for the fuselage also consist of strong metal tubes.

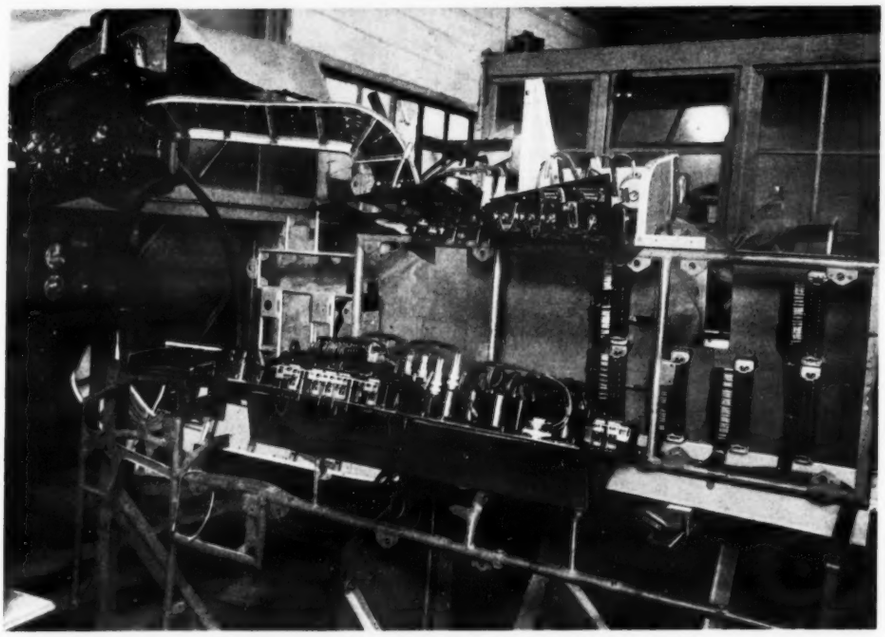
The frames for the six main sections of the fuselage are arranged in two parallel production lines.





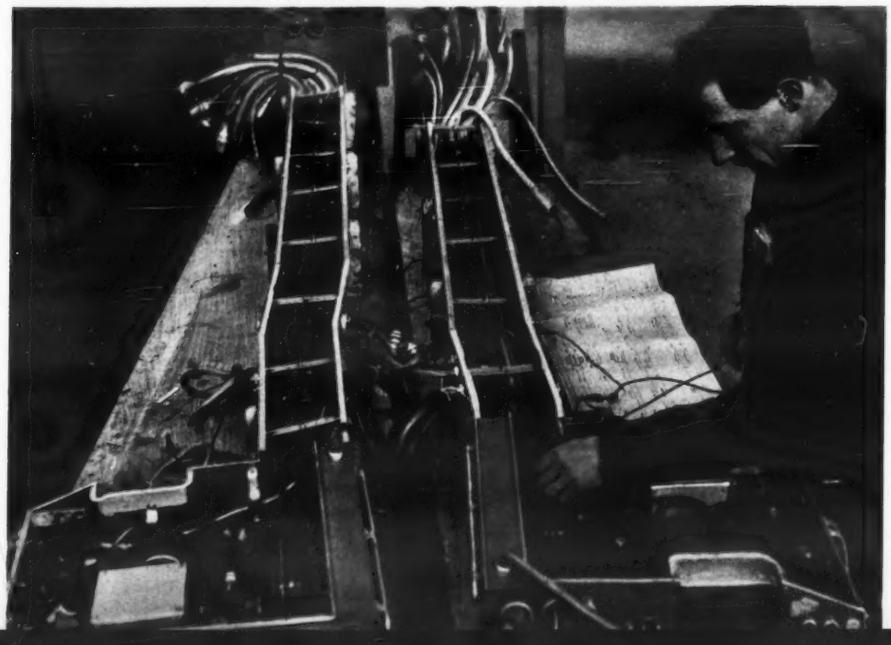
Particular care is given to keeping the points at which the cables and leads pass through the fuselage wall airtight.

One section of a flap (with guide rail) with upper covers removed. The controls for ailerons and flaps are easily accessible.



The instrument panels are built up on special frames, where all cables are also fitted.

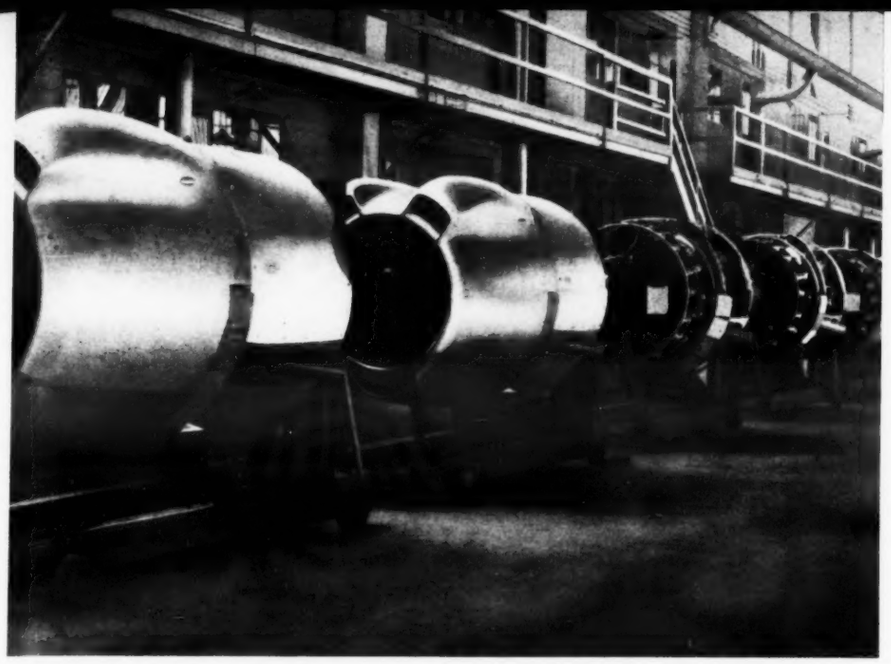
Electric leads for the wing unit, grouped into bunches and insulated, ready for installation.



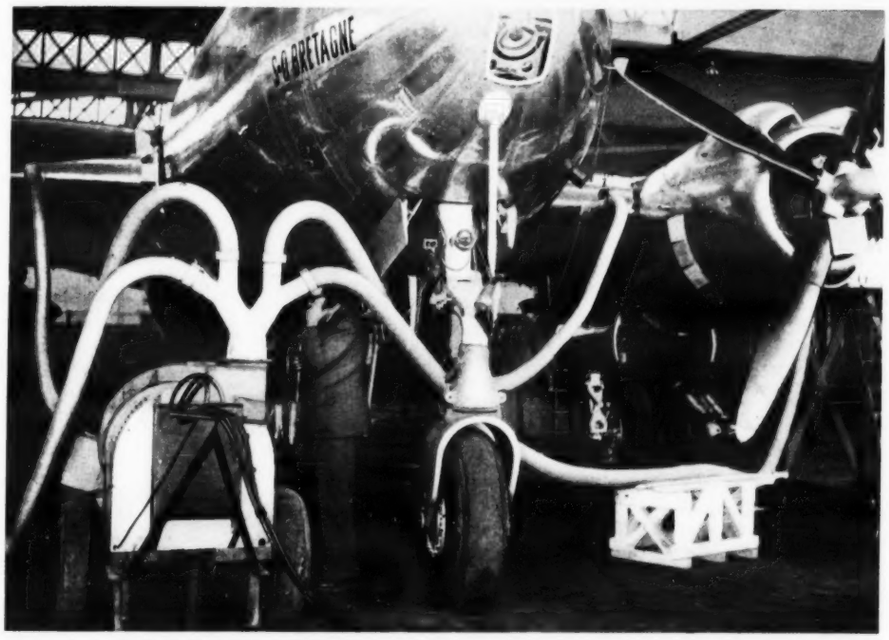
Final assembly of the "Bretagne" is by modern methods, typical of the new French aircraft industry. Efforts have been made to have as much work as possible done outside the narrow airframe and to fit the various equipment groups into the aircraft only during the final stage of assembly. This applies to the electric cables, hydraulic leads, instrument boards, etc. "When I was an apprentice," said the foreman, "fitting the cables was a job for a contortionist. Today it is child's play... like working in a laboratory!"

Particular attention is of course paid to keeping the points at which these leads pass through the fuselage wall airtight. The engines too, are made ready for installation on their own assembly line and fitted to the airframe only during the final stage. The quick release joints on the fire-proof bulkhead make fitting extremely rapid.

The company appears to be particularly proud of the design of the flaps and of the manner in which the complicated production problems connected with them have been solved. To open, the flaps slide backwards on guide rails of high-grade steel, at the same time being deflected downwards. Brackets must be particularly strong and fittings of very high quality if operation is to be completely reliable. Roughly forged steel parts are first planed, marked and machined, then heat-treated and finished to within a fraction of the required size. A hardening process (heating, cooling in an air current, tempering at 200° C) brings their strength up to



Assembly line for finished power plants. Pratt & Whitney R-2800 "Double Wasp" two-row radials.



Blower for testing the cabin heating on the ground. Two hoses supply the combustion air and two others fresh air to the heaters.

A good dozen SO 30 P's are already in operation or being flight tested.

185 kg/mm² (263,000 lbs./sq. in), calibrated clamps being used to prevent deformation of the pieces on removal from the annealing furnace. Finally, with the aid of accurate frames, the parts are worked down to the prescribed tolerances.

All materials, individual parts and structural groups are subjected to the most meticulous inspection before, during and after construction. This inspection is carried out not only by specialists employed by the manufacturers, but also by inspectors from the French Civil Air Registration authorities and from Air France. For the final check there are special adjustable testing devices for the electrical equipment and circuits and for the whole hydraulic system (undercarriage and flaps), and a pressure testing instrument for the pressurised cabin and its control equipment. A further special device, shown in the last picture but one, enables the cabin heating to be tested on the ground, a mobile blower, instead of the engine-driven compressor, supplying the necessary fresh air and combustion air to the heaters. These ground devices enable all the details of the equipment of each aircraft to be thoroughly tested before it undergoes its flying trials. They save time and money during actual flight tests.

For the various test and acceptance flights there is a runway about 4300 ft. (1300 m) long at Saint Nazaire-Montoir aerodrome. A large, modernly equipped hangar houses the finished aircraft ready for delivery to the customer.

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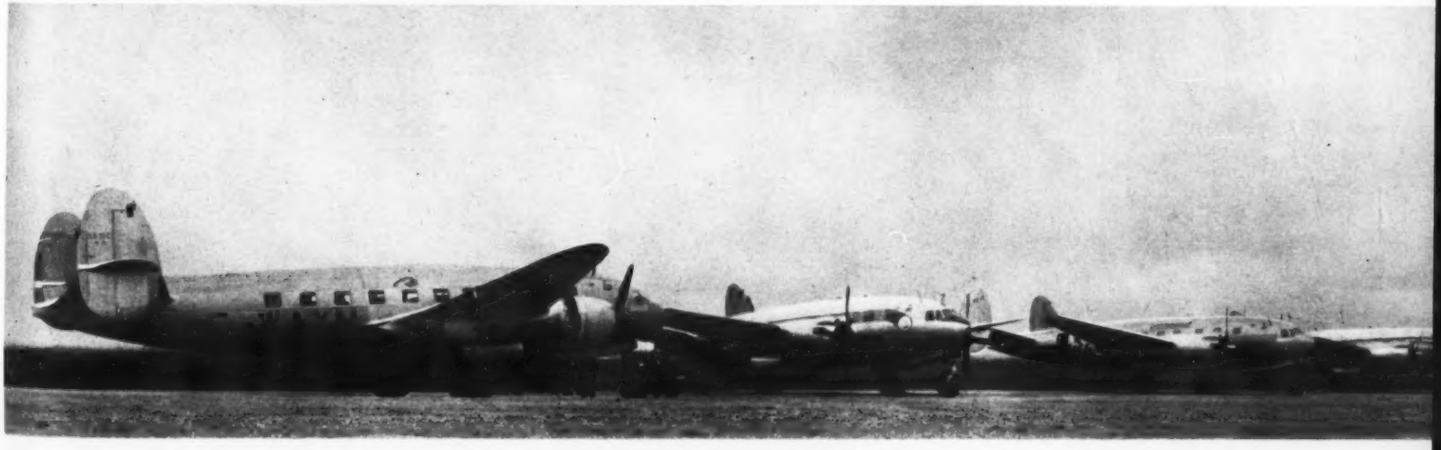


Pardon My Afterburner!

BY SCHOLER BANGS, LOS ANGELES

I never thought I'd be wearing earmuffs in sunny California!

There wasn't a cloud in the sky. Christmas was just a few days around the corner, but snow and heavy woolens were for easterners. I was in shirt-sleeves. A furnace-like heat rose from the sun-scorched concrete ramp. And here he was, this young engineer, handing me earmuffs! Big, wooly earmuffs that felt as if they were covering both sides of my face. I could feel the sweat begin to trickle.

The beating thunder of the jet, a hundred feet away, became a faint, lazy, comfortable rumble.

My escort waved toward the cockpit.

With a tremendous "PLOP," like the uncorking of a giant champagne bottle, unadulterated volcanic hell broke loose.

A dazzling spear of flame lanced back from the tailpipe.

A tremendous explosion that had no ending caught me and shook me. Force that has no description pummeled me from every side, played on my ribs like harp-strings, punched me in the stomach and then punched outward from within.

In my head a giant buzz-saw howled, and thought and time stood still. Five seconds? Five minutes? Five hours, it seemed.

And then silence. Complete, blessed, almost painful, utter silence.

I had been introduced to the Afterburner.

Aside from rocket power it is aviation's biggest booster, and aviation's biggest headache.

It has been called "the most tremendous noise maker over conceived by engineers."

Thunder and close-up artillery don't hold a candle to it. Experts who try to offer expressive comparisons place such noise producers above the "threshold of painful feeling," which they rate at a thousand ergs per second per square centimetre. On their scale an afterburner going full blast bombards bystanders, one hundred feet away and at one side, with a relative energy of from one million to ten million ergs per second per square centimetre. That, any way you look at it, is quite a parcel of ergs.

It is noise of an order that makes Schuyler Kleinhans, assistant chief engineer of Douglas Aircraft Company, who heads a noise control committee of the Aircraft Industries Association, to wonder "Is it worth the candle?" as he contemplates even bigger noises yet to come out of the throats of jet aircraft, and realizes that there isn't a great deal that can be done about it. "It's like saying, "I don't want guns to make a noise," he says.

It makes you glad to be wearing earmuffs, even with the thermometer nuzzling up to 100 degrees.

Californians are prone to boast. The loyal natives of Los Angeles enjoy nothing more than to trap the unwary tourist and besiege him with tales of the "biggest" oranges, oil wells, movie studios, and the world's biggest telescope atop nearby Mt. Palomar.

But the biggest gathering of aircraft plants in the world, clustered about Los Angeles, contains an anxious army of chief executives who are more than a little delighted that the bragging stops short of the big noises they are producing.

They count it little short of a miracle that with the first outburst of the first afterburner the citizenry did not rise up in wrath and consign them all to the unpopulated Mojave Desert, or a place even more distant, and hotter.

They're thankful that since the advent of the devastating contraption Angelenos have been more interested, successively, in their eye-watering "Smog," Korea, and gangland murders.

They've been given a breathing spell in which to go all out in a frantic and withall surprisingly successful attempt to swallow the super-thunder of their afterburner jets on the increasingly crowded engine runup ramps.

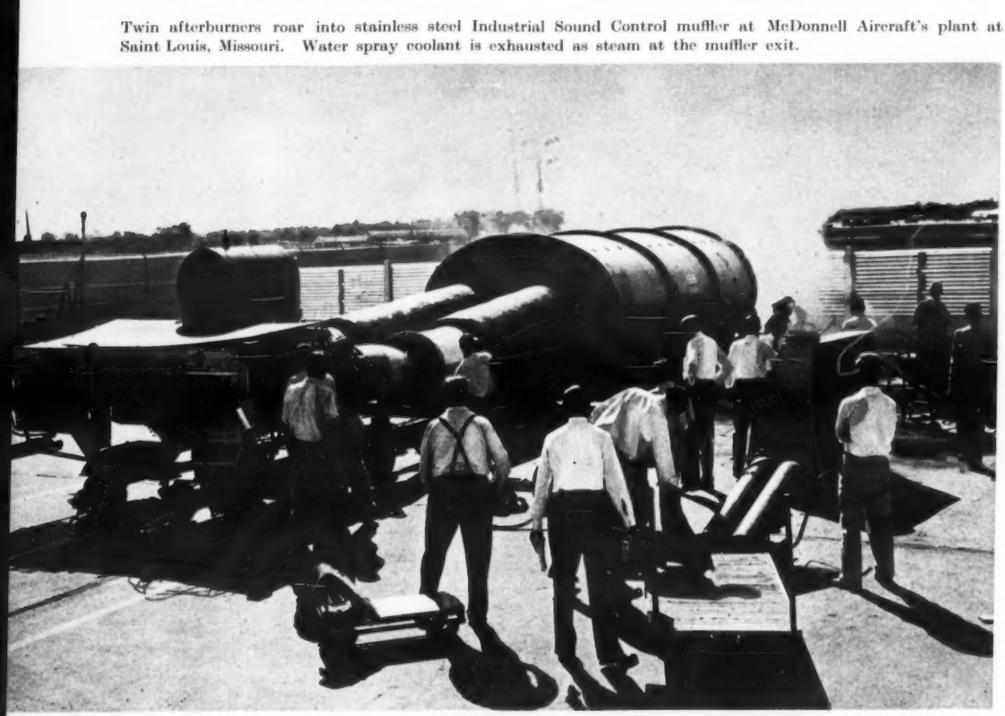
They, and their companion aircrafters throughout the United States, are spending millions literally, in the fashioning of king-size automobile mufflers to hook on to their afterburner tailpipes until the planes are ready to depart and take their noise with them.

They're simple appearing affairs, for the most part: Giant stainless steel barrels and long tubes in which the sound fury of the afterburner exhaust "gets lost."

And the sensitivity of the industry to its unwelcome by-product has created an entirely new, intensely competitive industry for the manufacture of noise mufflers.

The Maxim silencer, which filters noise through a system of giant metal baffles within a tube-like container, is selling like hotcakes. Sikorsky, at Bridgeport, Connecticut, almost completely muffles the barking roar of 600 h. p. Pratt & Whitney engines hooked up to one in tie-down tests of its

Twin afterburners roar into stainless steel Industrial Sound Control muffler at McDonnell Aircraft's plant at Saint Louis, Missouri. Water spray coolant is exhausted as steam at the muffler exit.



Sikorsky workers, and neighbors, hear only the whish of rotors when the H-19s piston engine exhausts through this king-size Maxim silencer.

H-19 helicopters. Lockheed began to feel once more like a "good neighbor" after trying one on a jet fighter afterburner at its testing station on Metropolitan Airport, Van Nuys, on the outskirts of Los Angeles; and has ordered three more.

Industrial Sound Control Company of Hartford, Connecticut, is ringing aviation industry doorbells to show a variety of mufflers employing labyrinths of noise-absorbing masonry panels. The firm also produces metal baffle silencers, and recently designed one to eat up the blast of twin afterburners mounted in the fighters of McDonnell Aircraft Corporation at Saint Louis, Missouri.

In the Los Angeles area, Marquardt Aircraft Company, whose big ram-jet engines outroar even the most ambitious afterburner, has designed its own muffler, filtering the exhaust through a slotted intake tube and into a barrel-like chamber, ten feet in diameter and rising vertically some forty feet, filled with metal shavings.

Without doubt, however, the most unique of the mufflers is one fashioned by Northrop Aircraft Co. at Hawthorne, near Los Angeles International Airport.

Standard practice demands that the conventional baffle plate or absorption labyrinth muffler be fitted at the intake with high-pressure water jets, which rob the searing afterburner exhaust of its initial heat and prevent the muffler's innards from reducing to blobs of molten metal.

Hawthorne city officials told Northrop that they were sorry, but they couldn't supply the company with the quantities of water such a muffler would need.

So, Northrop, aided by a bevy of heat engineers, aerodynamicists, and a Beverly Hills acoustics consultant, produced a muffler which looks for all the world like a factory chimney which has toppled and lies outstretched on the runup ramp, and is constructed of porous volcanic ash blocks. At the large "base" end of the "chimney" turning vanes are installed to divert upward the exhaust and whatever is left of noise poured into the entrance, ninety-five feet away, from the twin afterburners of a Northrop Scorpion F-89 fighter.

Afterburners of this Northrop F-89 may be producing a thunderous 155 decibels, but by the time the noise reaches the surface a mile below it will be under 85 decibels.

Afterburners are "the most tremendous noise makers ever conceived by engineers." They are an extension of the normal jet nozzle, into which additional fuel is injected. In this way thrust is increased by 30 to 40 per cent.

Walking into the interior of the big Northrop tube is like entering an engineering laboratory "silent room." All outside sounds vanish, swallowed by the noise-hungry volcanic blocks lining the floor, walls and ceiling. My conversation in there with Thomas Quayle, Northrop powerplant engineer, took on a hushed, cathedral quality. There were no echoes.

Quayle was justifiably proud of the waterless muffler, and explained that the aerodynamic shaping of the tube, a modified wind tunnel throat, keeps the hot exhaust stream from ever touching the sides of the structure. It is hurled through the tube wrapped in a boundary layer of fresh air drawn in through ducts at both sides of the muffler's entrance.

"When a plane is moved away after a hot run we can go inside without the slightest danger of scorching our feet on the floor blocks. They're just comfortably warm," Quayle said.

How much of the initial cataclysmic racket of their afterburners is being eliminated from the atmosphere surrounding the plants of jet-conscious American plane makers none will say definitely.

They all are confronted with the initial problem of afterburner noise which, released raw, makes life unbearably miserable for all in the immediate vicinity and can be counted upon to light up a factory telephone switchboard with calls from protesting home owners for blocks around.

Lockheed's Maxim silencer puffs like a locomotive when the afterburner roars.

A sound meter that swings its indicating needle to 85 decibels at the blast of a fire siren 75 feet away will leap to 150 decibels when an afterburner a hundred feet distant cuts loose.

The more optimistic of American muffler salesmen used to claim that their silencers would lower afterburner sound levels as much as 30 decibels.

Actual tests have not supported such claims, however, and today the muffler people, and aircraft plants using their products, are distinctly decibel-shy in talking about the extent of their noise reduction efforts.

A Lockheed engineer believes that the company's present Maxim silencer absorbs 85 to 90 per cent of the sound energy of an afterburner, but added "Absorption of 50 per cent of the initial energy of an unmuffled afterburner exhaust would result in a reduction of only three decibels on the decibel scale."

While they would like to reduce ground run afterburner noise to a relative whisper, the aircraft people at this stage seem to be delighted at the prospect of taming their Big Noise to the point where it will be in the "acceptable" range of a nearby boiler factory—say around 100 to 110 decibels.

Already, the companies burdened by afterburners have sensed that they no longer have to fear community uprisings.

Richard Goetz, Marquardt's administrative engineer, who remembers the howls of protest which arose when the company's then-unmuffled ram-jets were being tested at Venice, California, and at the big Kaiser steel plant in Fontana, where the noise made telephones dance across office desks, says that no complaints have been received since the muffler was installed. "We're all just happy as hell!" he says, with the conviction of one who has awakened from a nightmare and discovered it to be just that.

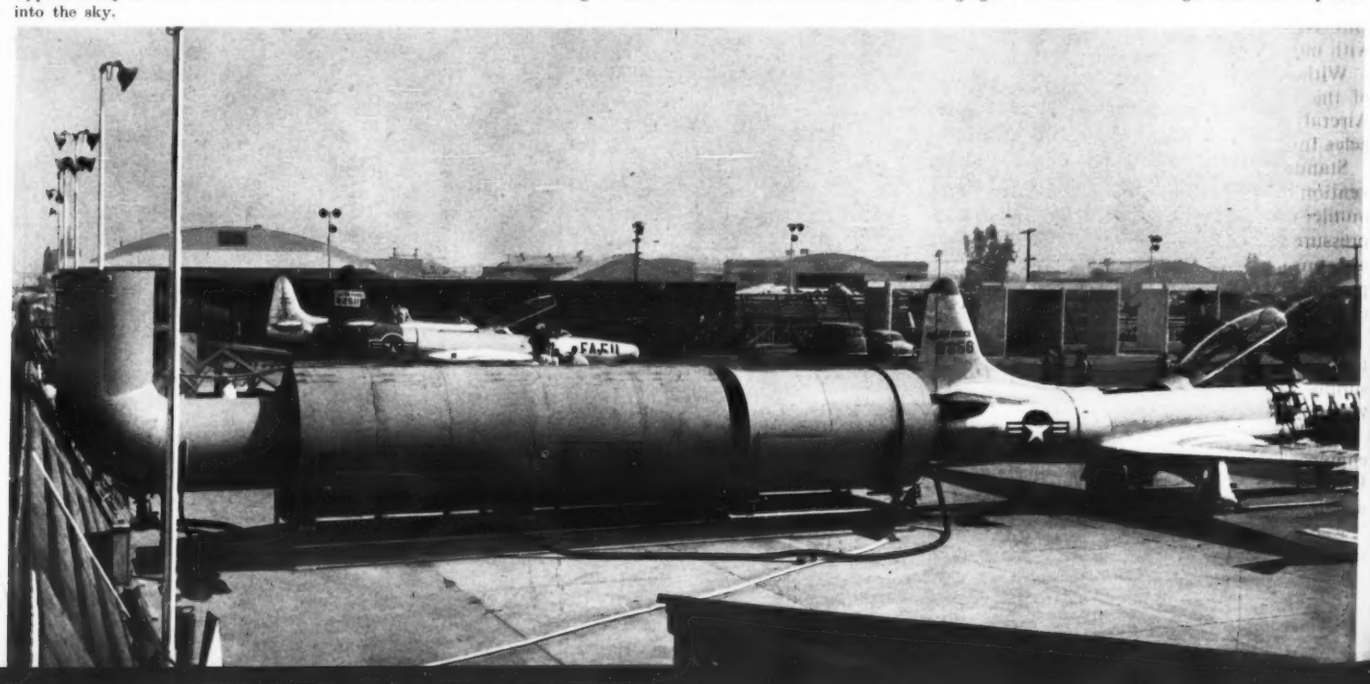
"Standing in the hangar door, it is impossible to tell whether or not the job is in operation unless you watch the rotor spin," says Edward M. Benham, Sikorsky's public relations manager, of the helicopter muffler. "Formerly every tie-down test resulted in complaints," he adds.

Lockheed and Northrop, both, are convinced that they now have the situation well in hand and will keep it so—until bigger and better noises come along.

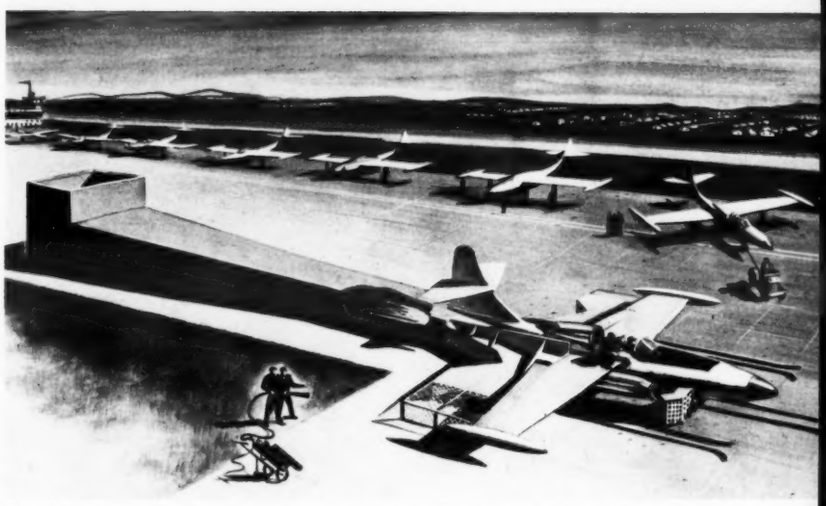
Their satisfaction is only recent, though, and it was at the start of 1950 that Lockheed officials were almost afraid to look a property owner in the face. They knew what was coming. In desperation, Lockheed dispatched a crew of engineers on a flying trip about the nation to learn what they could—which was little—about noise control. They came back loaded with blueprints and sales brochures describing silencers for piston and ordinary jet engine testing. No one seemed to know what to do about afterburner noise—if anything.

Putting together the best ideas gained in their transcontinental brainpicking, and adding a few of their own, the Lockheedians produced schematic proposals for a variety of afterburner silencers. The most simple muffler would cost $15,500 they estimated.

Typical today is this silencer, which swallows an afterburner's noise, digests it in a baffle-lined stomach, and then disgorges remnants of exhaust gas and sound upward into the sky.



Water flows at hundreds of gallons a minute into this Maxim silencer to spray and cool the sizzling afterburner jet gas before it hits the baffle plates within.



This sketch of Northrop's unique waterless muffler shows a Scorpion fighter blasting away. Without the muffler, residents in the neighbourhood beyond the field would be flooding the plant with complaints.

From there the cost estimates went on up to $77,810 for a complex muffler which would harness the jets of three planes at once, and to $79,000 for a model which would contain an entire F-90 twin-jet penetration fighter in an underground pit, and blanket the plane with huge, sound-paneled sliding covers while the exhaust vented into a big bafflebox.

By mid-summer, promised that a commercial muffler maker shortly would come up with a suitable silencer, Lockheed turned loose upon the 500,000 inhabitants of San Fernando Valley, who were becoming restless already under the initial bellowings of the afterburners, a full-scale public relations campaign.

In June the company spread throughout the valley an eight-page printed "pep talk." "What Lockheed Means To The Valley" was told glowingly to the residents of sixteen valley communities and cities. Lockheed payrolls released into the valley $693,000 each week in 1949 and supported some 48,000 persons, combining employees and their families. Then, two months later, came the second eight-page broadside, "The Roar Of Our Air Power," in which Lockheed took all of its good neighbors to one side and explained about noise, from the "rustling of leaves in breeze" to "thunder or artillery."

"From Dizzy Belles To Football Yells, Each And All Have Decibels," Lockheed explained, so that folks wouldn't think afterburners were the only offenders. The company's public relations writers even mentioned 20 decibels produced by "Lover's Lane whispers," and described truthfully as "blatant" the 100 decibels aroused by a youthful Lone Ranger shrieking "Hi Ho Silver!" Afterburners were described, and the brochure said "You'll hear strange sounds," and hinted that more might be forthcoming.

Oddly enough, the campaign aroused no more than passive interest, and the flood of noise complaints which had been anticipated as the ground testing of afterburner fighters advanced didn't materialize. One puzzled Lockheed official said: "We don't know whether to credit our campaign or the Korea war. We suspect, though, that the Korean affair may have spared us a bad time; that people feel it would be unpatriotic to protest the noise we're making while turning out fighting planes."

It shouldn't be assumed, however, that even with present mufflers the air industry feels itself free from the bugbear of "public reaction."

The mounting noise of the jets is more persistently elusive than existing sound control equipment can cope with.

You choke it off here and it comes out there.

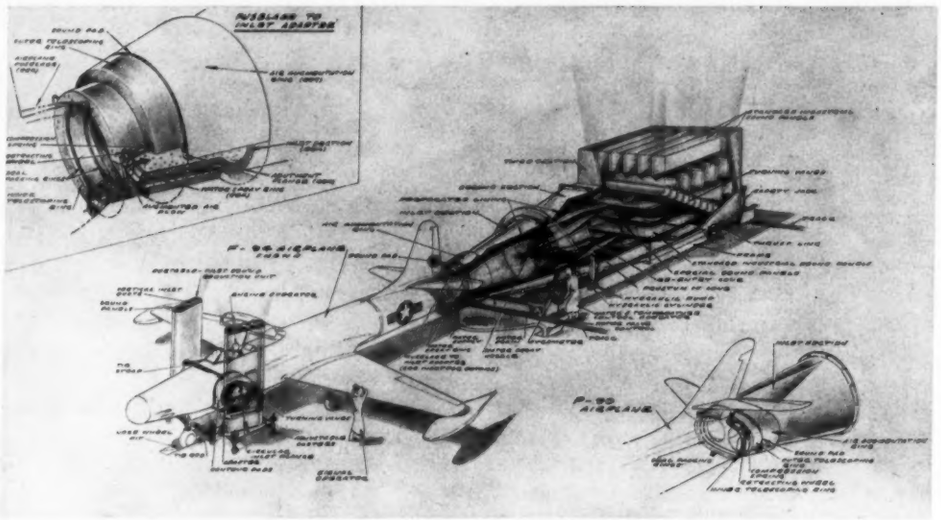
Its like trying to pick up a handful of quicksilver.

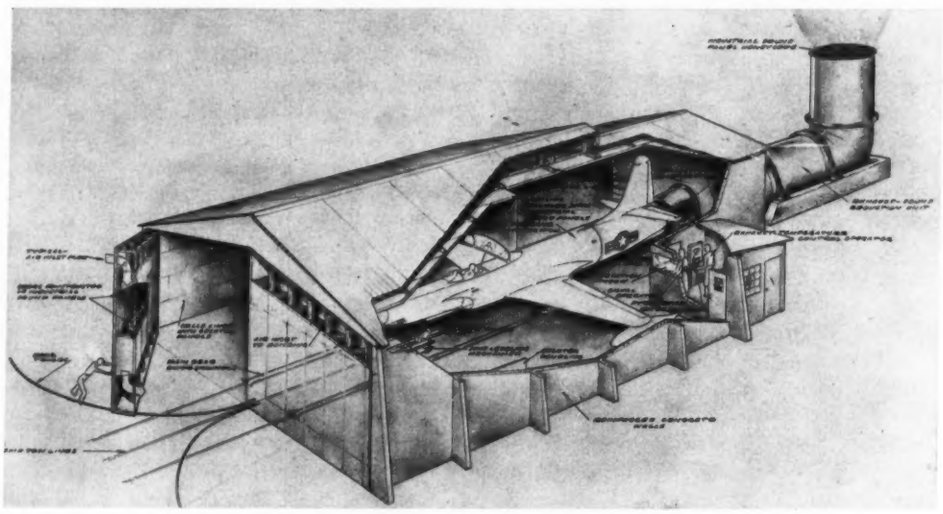
You aim the big, brutal overtones of an afterburner into the waiting maw of a silencer and discover the job only half done. From little slivers of space, tiny unsealed openings,

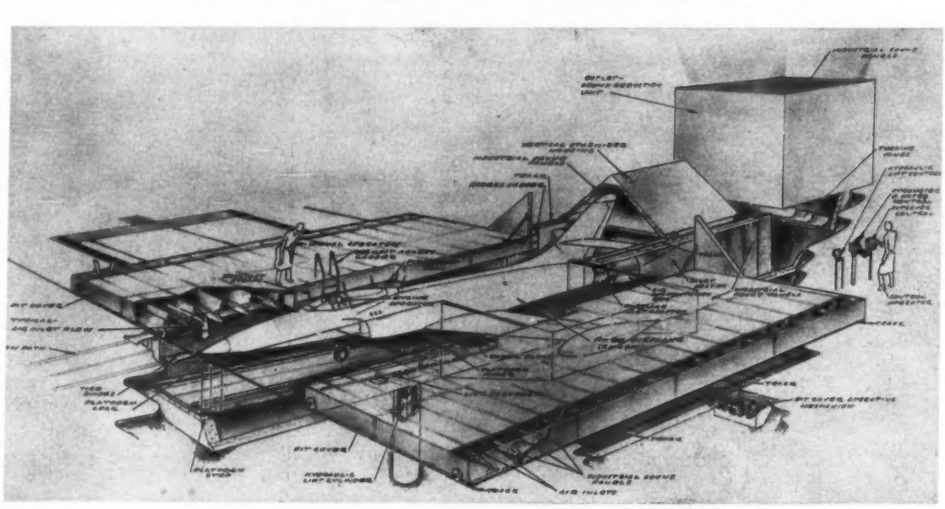
When the F-89 Scorpion is backed fully into this intake section of the Northrop muffler there will be no more than three inches separating plane and muffler structures, and this gap will be sealed with a blanket of glass wool to kill sound leaks.

Here is the cathedral-silent interior of the Northrop muffler, lined with porous volcanic ash blocks. Northrop engineers are examining aerodynamic turning vanes at the exhaust end, which will deliver residual gas vertically into the air.

Lockheed's Anti-Noise Team at Work



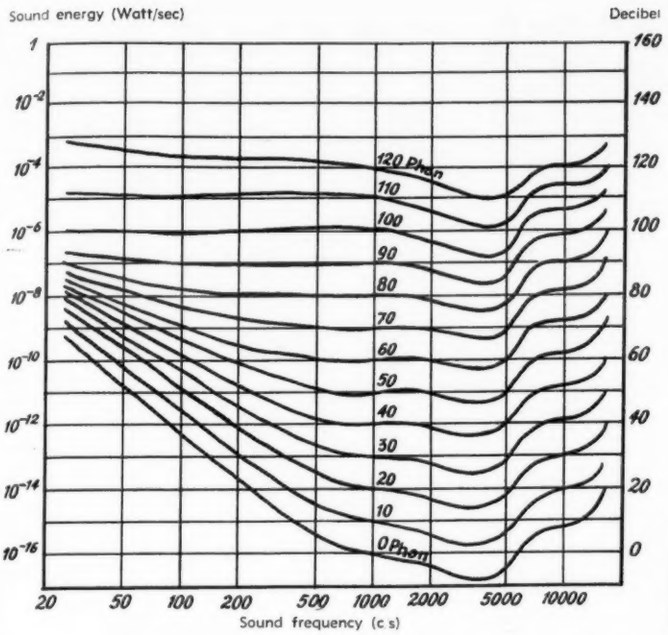




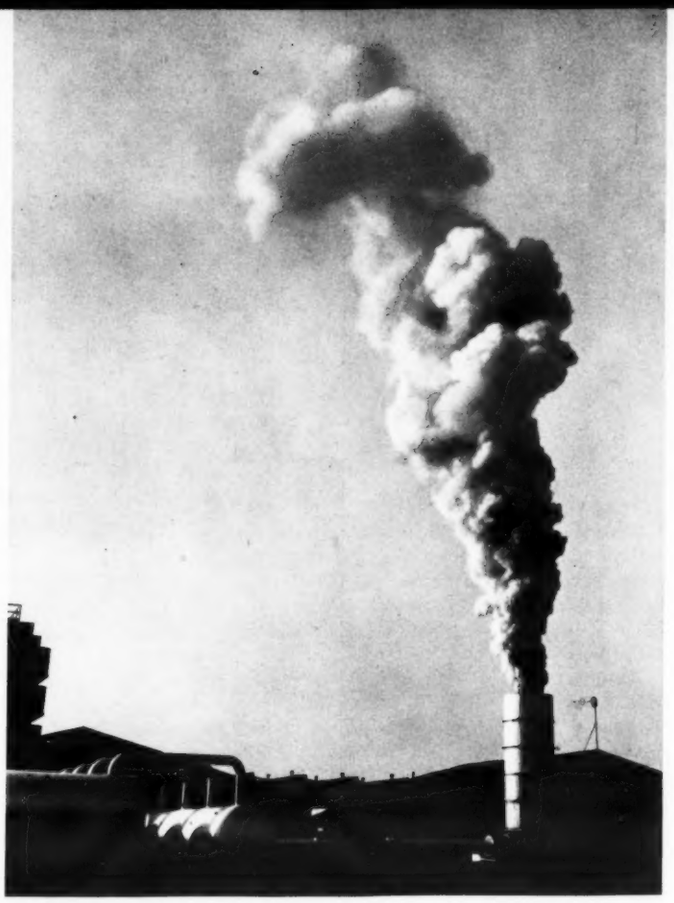
Three projects by Lockheed Aircraft Corporation for reducing noise during test runs of F-90 and F-94 jet fighters (with afterburners): Top picture shows a sound reduction unit brought up on rails behind the aircraft (a two-seater F-94) and connected to the jet nozzle by means of telescoping rings (see detail drawings). A system of sound panels, cooled by water under pressure, destroys the sound oscillations. Two additional mobile mufflers are placed in front of the intake ducts.

The centre picture shows a hangar type sound reduction unit, with celotex paneling, for the same jet fighter. Only a fairly weak humming noise comes out of the "noise chimney." Water control, pyrometer and signal operator are housed in a separate room.

The bottom picture depicts an underground unit. The aircraft (here a single-seat F-90) has been lowered into the pit by means of a lift platform, and the sound reduction unit attached with the aid of adjusting rings. Soundproof covers are now pushed over the wings, fuselage and tail unit, so as to screen off the intake noises and other decibel leaks. The test operator climbs down a ladder into the underworld.



Sound energy, phones and decibels. Sound intensity can be measured either as the energy which passes through one square centimetre per second at right angles to the direction of propagation (i.e. in Watts/sq.cm ; 1 Watt = 10^7 erg/sec) or by the logarithmic phone and decibel scale. The minimum sound intensity that can be perceived by the human ear is known as the threshold of audibility (0 phone) and depends on the sound energy and on the tone frequency. The ear is most sensitive to frequencies between 1000 and 5000 c/s. At higher or lower frequencies the sound energy must be greater if the sound is to be heard. The level beyond which sound oscillations cause pain is called the threshold of painful feeling. This is at about 120 phones (thunder, heavy artillery, unmuffled aircraft engine). At a frequency of 1000 c/s the phone scale coincides with the decibel scale. At other frequencies the above family of curves applies.



Biggest noise of the future probably will come from ram-jet engines such as are produced by Marquardt Aircraft Co. Marquardt designed this vertical muffler to gobble up their roar at its Van Nuys, California, plant, and has had no noise complaints from neighbors. (Muffler described in text.)

a screeching tornado of noise comes leaping out. That's why Northrop has tailored its muffler to give no more than three inches of clearance between tailpipes and the muffler structure when the plane is in position, and then seals the gap with a thick padding of glass wool.

And once you've toned down the jet blast, other noises come up and hit you in the face. They leak out of airframe openings enclosing the jet engine itself, and they rocket out from the plane's intake in a surprising fashion.

Cloyd Smith of Masco Engineering Service in Los Angeles, who represents Industrial Sound Control, has a lively interest in trying, now, to do something about intake noises, and says:

"At a distance 25 feet ahead of a jet engine intake the sound reading at full power may be no more than 104 decibels with a sound frequency of only 75 cycles per second.

"But, let the power be cut to 50 per cent and things begin to happen up front. The decibel reading jumps to 115, and the frequency shoots up to as high as 4800 cycles per second. And at 30 per cent power the noise is enough to knock your head off!"

What the aircraft people seemed to overlook, however, in the first blush of their alarm over what people might think, and even do about the noise, was that distance was their unanticipated ally.

With an afterburner running stark naked, and turning out a whopping 155 decibels life beside a tailpipe was, at best, on the unbearable side.

One thousand feet away, distance chopped the decibels to 145; to 130 at 2000 feet; to a "boiler factory" 110 at 3000 feet; and to a quite tolerable 85-90 decibels at 4000 feet. At 5000 feet the afterburner noise is "ambient," and blends with the normal clatter of everyday living.

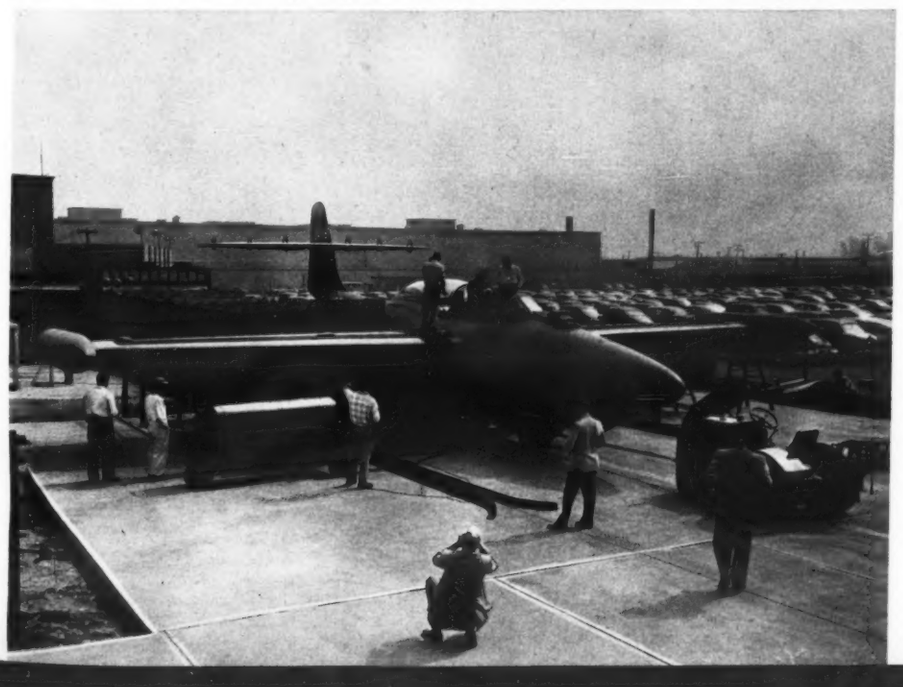
Perhaps, though, unanticipated by noise-sensitive aircraft presidents, a new breed of homo sapiens is in the making; one who likes his noise big, lusty, and beefsteak-raw.

Robert E. Gross, Lockheed's president, has in his files a letter from a professional man, a doctor, who had been on the receiving end of the company's noise public relations campaign.

The doctor wrote Mr. Gross:

"Your letter and folder concerning noise from aircraft is very unique and timely, and I trust that the noise will continue. I shall end my letter as you have yours: We shall be most happy to HEAR from you."

Ready for a test run is this Northrop Scorpion, backed into position against the intake of the company's muffler.



Air Power Facing the Iron Curtain - IV*

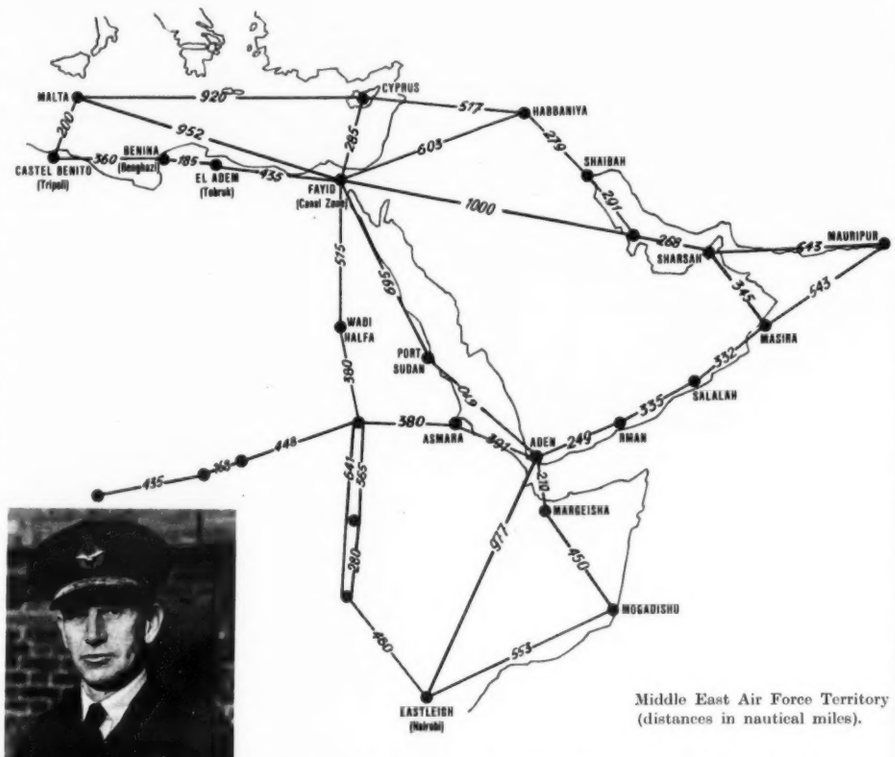
The British Middle East Air Force

BY JAMES H. STEVENS, LONDON

Nowhere along the borders of its vast territory does the command of the British Middle East Air Force have any direct contact with the Iron Curtain. Yet it forms an important link in the chain of air strength extending along the Western limits of the Soviet Union and her satellites, because in the event of war parts of the area "policed" by M.E.A.F. would immediately become the object of Soviet aggression. These parts are, notably, the rich oil fields of Iraq (which the Russians would reach after beating Persia into submission) and the Suez Canal Zone.

Although, within its vast confines, the Middle East Air Force is frequently referred to as "the Command," it is in fact a self-contained air force with its own headquarters, both operational and technical and with its own air transport units. Administratively, it is divided into five areas under the central control of H.Q./M.E.A.F. in the Suez Canal Zone. These five are Air Headquarters, Malta, for units there and in Libya; H.Q. 205 Group for the Canal Zone units, Cyprus and the Sudan; A.H.Q. Iraq for that country, Jordan and the Persian Gulf; H.Q. British Forces, Aden, for that Protectorate, Southern Arabia, Eritrea and British Somaliland; and A.H.Q. East Africa for Kenya.

From this it is obvious that the terrain of M.E.A.F. is very widely scattered and that lines of communication, even for aircraft, are attenuated. Furthermore, in these post-war days of the emancipation and self-determination of smaller nations some of the protection is, perhaps, less welcome than in times when active danger threatens. The shadow of the Bear may be more real, but it is nevertheless not so tangible as was the dust of a *panzerkorps* in the desert, and preventive measures are seldom received as gratefully as are relieving columns—even when, as is so often the case, these arrive too late. Because of these psychological problems, much of the work of M.E.A.F. has to be done with consummate tact and with a quiet lack of ostentation.



Middle East Air Force Territory (distances in nautical miles).

Air Marshal Sir John W. Baker, C.B., M.C., D.F.C., K.C.B., C.-in-C. of the Middle East Air Force.

The Royal Air Force has been associated with Egypt and Iraq since its birth on April 1, 1918 and, even before then, the Royal Flying Corps was operating from bases in those countries. The names of Ismailia, Abu Sueir, Abyad, and others that have

* Cf. "Interavia, Review of World Aviation," Nos. 5, 7 and 8-9, 1950.

Typical night scene at Fayid aerodrome, one of the busiest centres in the Middle East Air Force territory.

R.A.F. Mosquitos over the Suez Canal.

disappeared, such as Aboukir and Heliopolis, are knit deep into the history of the R.A.F. Under the terms of the Anglo-Egyptian Treaty of 1936, Britain undertook to withdraw her forces from Egypt, with the exception of the narrow strip along the West bank of the Canal known as the Suez Canal Defence Zone, and to review the occupation of this again in discussion with Egypt in 1961—the date at which the entire control of the Canal itself is due to be transferred to the Egyptian Government. King Farouk's Government, however, is at present insisting that Britain withdraw her forces at a much earlier date.

Since the future of British Forces in this part of the Mediterranean is manifestly uncertain, it creates a difficult situation when money is required for buildings and other permanent fixtures, so that, apart from buildings at the original stations, most M.E.A.F. units are living and working in temporary huts and hangars. During a visit, made earlier this year through the courtesy of the British Air Ministry, I saw the work of M.E.A.F. at a number of their stations, although as I was mainly interested in technical problems, I concentrated in detail on certain stations rather than making a hurried general tour of the whole command.

The duties of M.E.A.F. are divided into its own defensive and police work on the one hand, with staging and transport commitments on the other.

Staging Work

M.E.A.F. airfields include a large number of the staging points on the Transport Command routes to Africa and the Far East: Luqa (Malta), Fayid (Canal Zone), Khartoum (Sudan), Eastleigh (Nairobi), Habbaniyah (Iraq), Basrah, Shaibah, Bahrein and Mauripur. At these stations en-route servicing echelons have been formed that are capable of refuelling and doing daily inspections on any of some thirty types, for reinforcing flights by any operational aeroplane must be catered for. At Fayid, in particular, which is a central station with routes radiating from it in six main directions, the loading is heavy and is frequently increased by diversions from Almaza Civil Airport, which is subject to ground mist at night. The ground equipment at Fayid is an astonishing sight with its array of jacks, trolleys, ladders and maintenance platforms—even passenger steps for the "Constellations," "Argonauts" and "Skymasters" that arrive quite frequently. Backing this aerodrome there are of course all the accommodation and messing facilities needed to clear large arrivals of passenger and troop movements.

Similar needs have to be met at the other staging points, but the load on Fayid is probably the heaviest because of its position. Furthermore, it lies roughly 1,000 miles from Luqa and Khartoum—a good day's flying—and 600 miles from Habbaniyah, where night landing facilities are poor. This results in a most inconvenient loading for the ground staff, since most aeroplanes come in early, peaking at about 11.00 hrs. and requiring a 2-hour turnround to get to the next point before dark; or they arrive in the afternoon, 14.00 to 17.00 hrs., for a night stop and, probably, a dawn start. As may be imagined, this is heavy work and the tanker load, in particular, is terrific since many of the four-engined aircraft will require as much as 2,500 gallons each; in addition a complete range of fuels, including kerosene, has to be carried. The team needed to give a 2-hour turnround for a four-engined type, such as the "Hastings" or "York" would consist of 14 R.A.F. tradesmen, including two tanker drivers, and 4 native labourers for cleaning. The cleaning is quite a large job on these transit aeroplanes—particularly on the troopers after a bumpy trip.

R.A.F. Regiment armoured cars passing a camel train.

Servicing a Bristol Beaufighter target-tower at Shallufa.

of the "Viking"), Douglas "Dakotas" and a few Avro "Anson 19s." The "Dakotas," after giving long and faithful service, are on their way out and most of the routes are now regularly operated by the "Valettas." The Ansons are used mainly for communications, although they sometimes deputise on the shorter routes when the load is small.

A trip on one of the "bread-and-butter" runs, where goods and passengers are on- and off-loaded at each stop like a local delivery van, is an interesting experience. With the attenuated communications in M.E.A.F. crossing many borders, air transportation is a great advantage—and one that has been realized, so that demands for space usually exceed supply and an elaborate priority system for both men and material is in use. I made one trip along the Northern Coast of Africa which did much to show me the problems. First of all, several through aeroplanes had been delayed for one reason or another and local accommodation was stretched to the limit—huts and tents. Nevertheless, we were duly called at 03.30 hrs. and, after a breakfast of egg-and-chips, took off at 06.00 in a cloudy desert dawn—it was only late March and still cool at nights with frequent thunder storms. After about 1½ hours we passed the defences of Tobruk and landed at El Adem, for our second breakfast—egg-and-chips.

Final stages in the overhaul of a Spitfire F.R. 18 before flight testing at Abyad.

Internal Transport

M.E.A.F. operates scheduled R.A.F. services for passengers and freight within the confines of its territory, *i.e.*, regular stopping runs are made to Eastleigh, calling at Khartoum and Wadi Halfa; to Aden down the Red Sea, or by way of the Nile and Eritrea; to Malta, with stops at El Adem, Benina and Castel Benito; to Cyprus, and to Habbaniyah and the Persian Gulf.

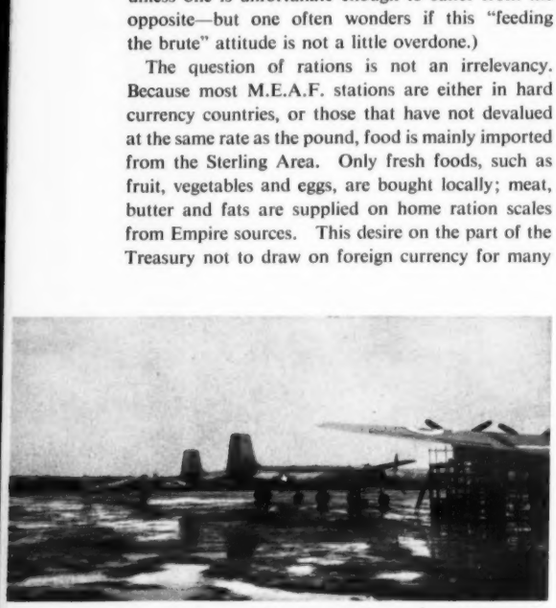
The main transport units operating these services have Vickers Armstrongs "Valettas" (military version

Cadets on Exercise "Sunray" at Shallufa.

One of the engine overhaul shops of 109 M.U. at Abyad.

An hour on the ground, a change of passengers and freight and we left for the hour's flight to Benina, where we had our elevenses—especially tasty egg-and-chips with bacon. Another hour's flight brought us to bomb-scarred Castel Benito with its cool white buildings and mimosa groves, just flowering. Here we had our lunch—egg-and-chips—and a short rest before flying North to Luqa. As we rumbled over the blue sea and watched the red shores of Africa recede, the stronger passengers tackled the hard-boiled eggs and sandwiches in their tuck boxes! (Like all air lines Transport Command and the transport squadrons of M.E.A.F. have a profound faith in the feeding of passengers, so that, both in flight and at stops, the first consideration is food. Certainly, one does find a good appetite when flying—unless one is unfortunate enough to suffer from the opposite—but one often wonders if this "feeding the brute" attitude is not a little overdone.)

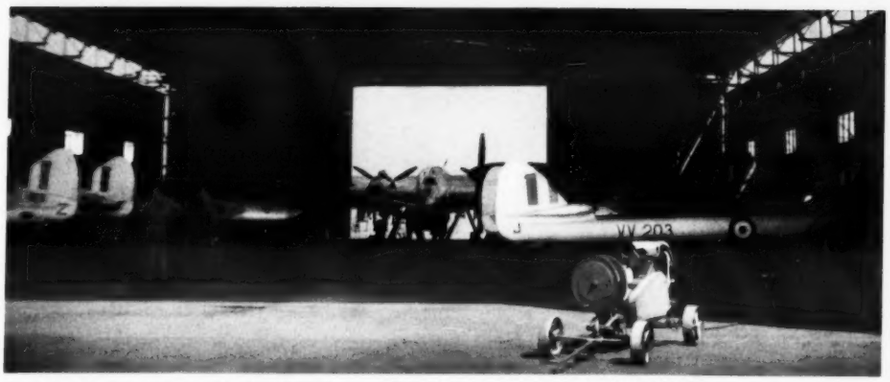
The question of rations is not an irrelevancy. Because most M.E.A.F. stations are either in hard currency countries, or those that have not devalued at the same rate as the pound, food is mainly imported from the Sterling Area. Only fresh foods, such as fruit, vegetables and eggs, are bought locally; meat, butter and fats are supplied on home ration scales from Empire sources. This desire on the part of the Treasury not to draw on foreign currency for many day-to-day needs certainly does not make administration any the easier. In the same way, only part of the Air Force pay, too, is available in local currency, a portion of it being retained in England by transferring it to the officer's home account.



Luqa, Malta. Two Douglas A-26 Invaders of the U.S.A.F. and a de Havilland Mosquito P.R. 34 from England, on a visit to the island.

Operational Commitments

The Mediterranean units of M.E.A.F. are mainly fighter squadrons forming the basis of the defence of the Suez Canal and the shipping lanes and are based on the Canal Zone or the islands of Malta and Cyprus. There are also night fighter and reconnaissance squadrons, as well as some bomber units. Malta is also the principal air-sea rescue base for the Mediterranean.



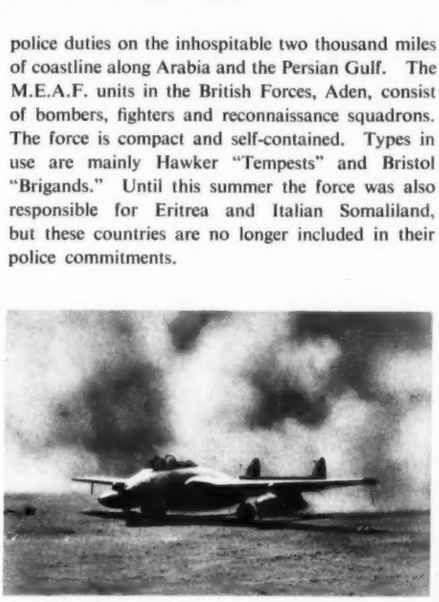
Servicing shop at Nicosia, showing Vampires, a Tempest and a target-towing beaufighter.

The fighter squadrons of Malta, Cyprus and the Canal Zone are now re-equipped with de Havilland "Vampires" in place of the "Spitfires" and "Tempests" that were in use at the time of the Palestine War. Both Cyprus and the desert provide excellent terrain for operational practice and the gunnery records of M.E.A.F. fighters are excellent. The problem of sand puts the armourers on their mettle and, in their efforts to avoid jammed feeds, they have actually achieved unusually low stoppage rates.

The night fighter units are equipped with de Havilland "Mosquitos," as also are the bomber squadrons. There are also a number of fighter-reconnaissance "Spitfires" still in service.

At Malta, the air-sea rescue squadrons have Avro "Lancasters" equipped to carry airborne lifeboats. The air-sea rescue aircraft at Malta are, of course, required as much for naval manœuvres and for the airliners crossing the Mediterranean as for the help of R.A.F. aeroplanes, and there is always a duty "Lancaster" and crew standing by. All M.E.A.F. units are self-supporting, and there is a completely equipped repair and overhaul base at Marsaxkalok for these boats and their gear. Fortunately, the lifeboats are not often needed for actual rescues, but practice drops are made regularly. After a drop the boat is declared unserviceable and is completely overhauled, so that this work, together with periodic inspection of all the gear and the re-packing of parachutes keeps the base well occupied.

Farther South, in the Aden Protectorate, the R.A.F. assumes a more militant rôle, for there are always police duties on the inhospitable two thousand miles of coastline along Arabia and the Persian Gulf. The M.E.A.F. units in the British Forces, Aden, consist of bombers, fighters and reconnaissance squadrons. The force is compact and self-contained. Types in use are mainly Hawker "Tempests" and Bristol "Brigands." Until this summer the force was also responsible for Eritrea and Italian Somaliland, but these countries are no longer included in their police commitments.



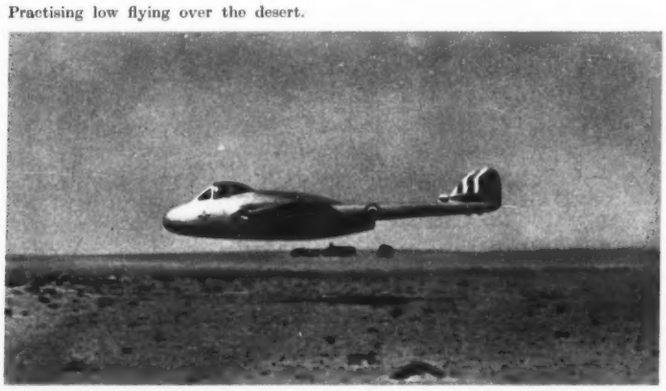
A de Havilland "Vampire" of No. 6 Squadron from the Canal Zone of Egypt, fitted with long range tanks.

"Sunray"

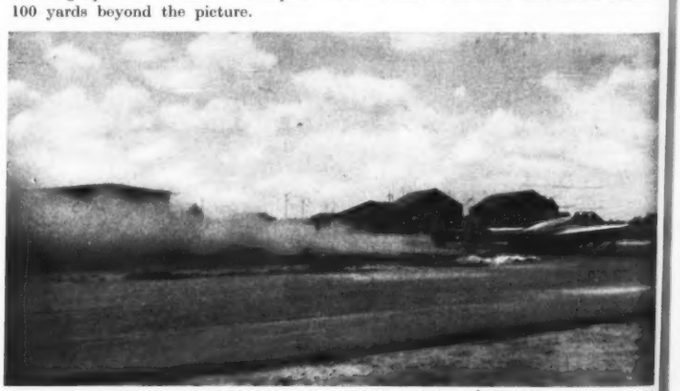
M.E.A.F. is regarded more as a nucleus upon which to build by reinforcement in an emergency, and one of their most important commitments is to maintain the bases for R.A.F. "Exercise Sunray." This is, in essence, the whole operation of rapid overseas movement of home-based bomber squadrons.

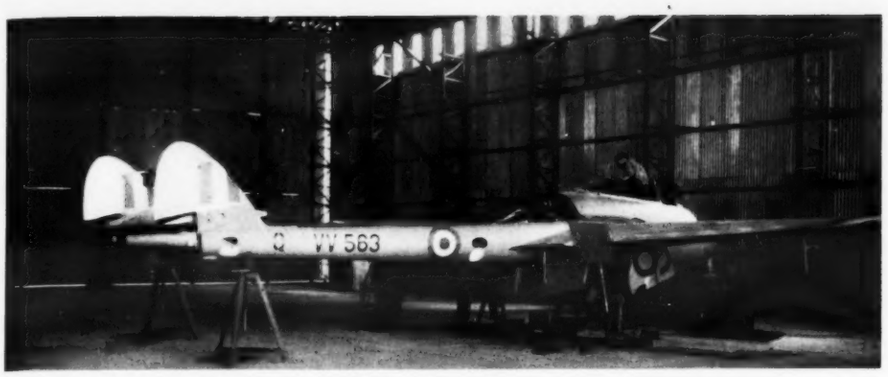
Once a month aircraft from each squadron of Bomber Command in turn fly out non-stop to the Canal Zone for an intensive course of operational training under desert conditions. In the winter

Practising low flying over the desert.



Running up a de Havilland "Vampire" at Deversoir. The solid dust cloud extends 100 yards beyond the picture.





Routine servicing of a de Havilland "Vampire" at Deversoir.

(October to March) two whole squadrons of "Lincolns" and three "Mosquito" squadrons arrive, but in the hot summer months only a single squadron of "Lincolns" is sent. Long-range bombing, air gunnery and navigation are carried out in practically active-service surroundings. In addition to their air crews, the squadrons bring only their first-line servicing teams—that is the ground staff for between-flights and daily servicing only. Second-line or periodic maintenance, and any repair work is carried out by the station servicing personnel at Shallufa. This exercise, therefore, gives the bomber squadron experience of working away from its home base and, at the same time, the M.E.A.F. personnel get practice in dealing with strange units under operational conditions such as they would meet in the first stages of an emergency before the ground backing of new units could arrive.

Maintenance

Such, then, are the commitments and the disposition of the Middle East Air Force as far as security considerations allow them to be described. Admittedly, an intelligent passenger on the deck of any ship passing on its slow journey through the Suez Canal could learn a good deal about the equipment and disposition of the defences of that sector—however, there is no point in saving him the journey! But there are other sides to the question: the behaviour of equipment in these climates and the twin problems of supply and maintenance.

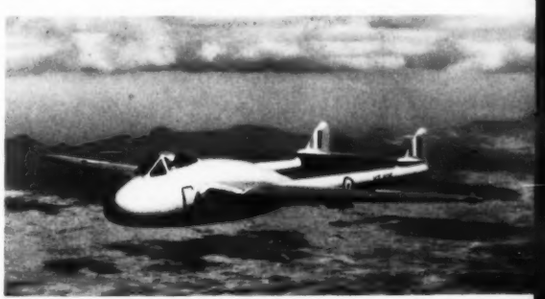
In a self-contained air force the maintenance backing is of prime importance; if an army marches on its stomach, an air force flies on its ground staff. This is becoming increasingly true as aeroplanes become faster and more complicated. The Royal Air Force, has, since the war, perfected its servicing and maintenance organization—partly, it is true, under the dire need of getting the maximum work from the fewest possible men because of the reduced manpower of the British fighting forces. To do this, two things were necessary: servicing work was divided into classifications and planned servicing was introduced. Servicing is divided into First Line, daily and routine work done by the *Squadrons;* Second Line, periodic inspection and minor repair by the *Station;* and Third and Fourth Line, major overhauls, repairs, salvage and storage carried out by *Maintenance Units.* Planned Servicing does not enter directly into this account, but it is a careful organizing of routine inspection work which has resulted in startling reductions in servicing time and the number of personnel required—throughout my visit to M.E.A.F. I found it being enthusiastically used by all ranks.

Maintenance Units in Malta, the Canal Zone and Aden carry out major overhauls and repairs to aeroplanes, aero-engines, motor transport and ground equipment of M.E.A.F. and also repairs to machines in transit. The workshop facilities are very complete because any job that cannot be tackled is likely to be scrapped, since shipping home to the manufacturer is very expensive and slow. Both R.A.F. tradesmen and local labour are used for the work, with N.C.O.s-in-charge taking the place of foremen in a factory. At 109 M.U. in the Canal Zone the overhaul of "Merlin" and "Hercules" engines is organized on a production line basis bearing comparison with that of an aero-engine factory. Airframe overhaul is on a more individual basis, but the work is broken into components which go each to the appropriate shop, *e.g.*, main planes, fuselages, control surfaces, hydraulic and undercarriage units, etc. Instruments, too, are checked against standards and overhauled, while at 107 M.U. the standards themselves are subjected to laboratory control. As an indication of the completeness of the organisation and equipment it is worth recording that fuel, oil and other materials are all subject to analysis by the Aeronautical Inspection Service of the R.A.F. at this station.

Six de Havilland "Vampires" flying over the Cyprus coast.

Under tropical conditions the two great problems are sand and deterioration. Sand is all-pervading and penetrates everything—even apparently sealed components. Its abrasive action is less than one would expect, but it clogs moving parts, particularly affecting armament, instruments and radio. Constant cleaning, on the field between flights and in the workshop, is the only effective answer—it is impossible to keep the sand out of building or cowling, so that the only thing to do is to remove it when it is deposited. Deterioration due to heat particularly affects electrical wiring insulation and hydraulic seals. Parts in store and aeroplanes idle on the ground go most quickly.

The "Vampire" jet fighters are giving excellent service and neither the extreme humidity of Malta nor the semi-tropical conditions of the desert are causing any unforeseen problems. The "Goblin" engines apparently consume the sand without difficulty, which is just as well since it is almost impossible to keep taxi-tracks and runways clear of sand and grit. The biggest problem is cooling the cockpit on the ground and up to about 10,000 ft. in summertime. Temperatures of 140 deg. F. are common and the tiny glazed cockpit of a fighter is almost unendurable either to the pilot or the mechanic. A refrigerator in the pressurizing system can solve the pilot's problem relatively simply, but on active service in the desert it is not easy to provide shade for the mechanic.



A "Vampire 5" flying above the central plain of Cyprus.

Yet, despite these high temperatures men quickly become acclimatized and in about a fortnight they are able to work in the stuffy fuselages. In summer, most of the work is done in the early morning, the men wearing only shorts and working for spells of about 30 minutes at a time in enclosed places. It is the general opinion that the humidity of Malta—often 90/90 in the summer—is far more exhausting than the dry heat of the desert.

Conclusion

The Middle East Air Force is, then, an efficient, well-organized and self-contained operational entity, well-practised in combating its local problems, that forms an essential part of the integrated Western Defence Forces. Although not a big force, it has a very large area to cover, and upon it rest the foundations of the defence of the oil wells of Iraq and Iran, of India and Pakistan, and of Africa, as well as that of the Mediterranean itself—the soft belly of the Western Union. It is through the airfields of M.E.A.F. that the frontline countries facing the U.S.S.R. and the southernmost states of the Cominform would be reinforced in an emergency by the R.A.F. and the U.S.A.F., just as it would be M.E.A.F. that would keep open the lines of communication and supply from the West.

Nature's Navigators

BY SQUADRON LEADER A. R. BUNN, M. B. E., A. R. AE. S., C. S. L. A. E.

It has been said, perhaps too often, that there is nothing new under the sun, but there is probably no sphere in which this time-worn saw is more applicable than in the world of science, which is constantly striving to attain some new discovery. How often has scientific research spent years in developing and producing some world-shattering system or apparatus, only to find that Dame Nature has got there first by many thousands of years, and that hitherto inexplicable phenomena can be explained only in terms of the "new" development which is, in fact, not new at all. It should be a humbling, if not a humiliating, reflection that this applies as much to the science of air navigation as it does to any other field, and that even now the secrets of the navigational skill of homing pigeons and migratory birds are still secrets, although scientists and ornithologists of many nations have been attempting to probe them for a number of years.

Take, for example, the bat. This creature's almost uncanny ability to avoid obstacles even in complete darkness has always been difficult to reconcile with the old tag "as blind as a bat," and this gift has intrigued the curiosity of investigators for more than a century. However, it was not until the war-time development of Radar and Sonar and the evidence provided by the supersonic valve analyser that the secret of the bat's extraordinary powers was revealed—and the fact demonstrated that Nature had once more anticipated and produced in more perfect form the latest product of the scientific brain. Over a century ago, a Swiss scientist had found that when a bat's eyes were covered he could still give a perfect exhibition of blind flying, but that, with the ears covered, the "flittermouse" preferred to remain grounded and, if he could be persuaded to become airborne, that he blundered helplessly into everything in his path, with none of his customary acrobatic skill.

A number of other investigators had demonstrated the existence of this "sixth sense" by showing that bats were able to avoid wires stretched across a blacked-out room. Others found, too, that this sense was not only accurate, but that its powers of discrimination were astounding. A pebble thrown into the air may deceive a bat into making a power dive on the suspected "insect," but he will swerve away at the last minute upon sensing the error; anglers' flies at dusk have a similar attraction, but the bat never takes the fly, although he may be hooked in the wing or the body—he is clearly able to distinguish between the real and the artificial even at the end of his guided power dive. Bats, flying along the hedgerows, can actually pick a spider or an insect off a leaf while in flight when the human eye has difficulty in distinguishing the leaf itself. These investigators recognised and appreciated this uncanny accuracy and discriminatory power, but although a promising start had been made at solving the age-old mystery, the final answer remained in the realm of conjecture until the supersonic wave analyser showed that the bat possessed a "Radar" equipment more perfect than any the human mind had developed.

This apparatus, which can detect and measure noiseless vibrations far above the highest note apparent to the human ear, revealed that the bat in flight emits, generally through the open mouth and in some cases through the nostrils, an interrupted train of high-frequency sound. These vibrations, with a frequency approximating 50,000 per second (some 20,000 above the highest frequency detectable by the human ear), with periods of transmission occurring up to 60 times a second and lasting for only one two-hundredth of a second, are reflected from objects in their path and return to the bat as an echo. As the time interval between the supersonic "squeak" and its echo is proportional to the distance from the reflecting body, the bat is able to fix its position with great accuracy.

One of the essential features of Radar and Sonar equipment is the suppression of the receiver while transmission is made so that only the echo is received. To produce the same effect on Herr Fledermaus, Nature has interconnected the powerful larynx and sensitive ear; each time the bat "transmits," a muscle at the base of the ear contracts, making him deaf to his own "voice," and at the end of the transmission relaxes and permits reception of the returning echo.

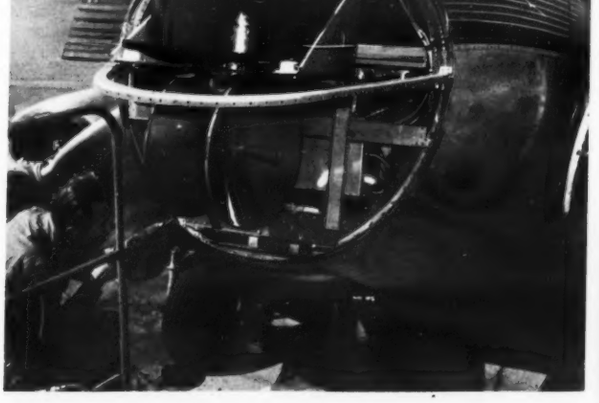
However humble the bat may be, he is not as insignificant as Nature's progenitor of the gyroscope for automatic guidance in flight. Fifty million years ago, swarms of tiny two-winged flies, the Diptera, were using gyroscopic navigational equipment to find their way under conditions of zero ceiling and nil visibility through swamp mists and vapours. The perfection of a most successful blind-flying apparatus enabled the Diptera to survive under almost intolerable conditions to such good effect that this evolutionary struggle for self-preservation resulted in the existence of some fifty thousand species of Diptera scattered throughout the world today. The insects of fifty million years ago, specimens of which have been found perfectly preserved in pieces of clear amber, possessed the same well-developed flight instruments which their numerous descendants use today. Among the latter is the common house-fly, whose acrobatic agility in avoiding both obstacles and lethal attacks from well-directed swatters is due solely to this gyroscopic automatic pilot with which it is equipped.

Strictly speaking, the Diptera do not use a gyroscope as such as the sensitive element of the "instrument," for in place of a spinning mass are rapidly vibrating rod-like weights, called *Halteres*, universally suspended in a ring of muscles. In effect these halteres are similar to short sticks pushed through the centre of a "drum" of muscles, and they are effectively designed to give maximum momentum with minimum weight, so achieving engineering perfection. The assembly of

Two kinds of radar instrument.

The bat emits through its mouth and nostrils supersonic waves whose returning echoes enable it to perceive and avoid obstacles.

This man-made warning apparatus (Allison radar equipment in the nose of a DC-3) serves the same purpose.



Natural and Man-made "Gyroscopes."

For fifty million years flies and midges have been using "artificial horizons." Their *Halteres* (rapidly vibrating rod-like weights) are balancing organs which are not only capable of detecting stability deviations but also of correcting them.

With its large body and small wings the house-fly looks clumsy. But try and catch it!

Man's artificial horizon is not to be despised, though somewhat more costly!

the minute components of this "instrument" can only be called exquisite—a muscular system to drive the Halteres, a nervous system which detects their indications and differentiates between linear and angular movements, coupled by a wing-muscle control system to a special pair of balancer wings for automatic correction of flight deviations from the straight and level. If the Diptera are deprived of their Halteres, their flight becomes uncontrolled and, like the bats, inevitably ends in a crash landing.

Even then, the perfection of such apparatus as the Diptera's tiny gyroscopic control, in which tolerances of one ten-thousandth of an inch would be gross, presents a perfection unattainable by the most precise of precision engineering processes. Human endeavour, it seems, can only continue to admire and attempt to emulate Nature's incomparable workmanship while research goes ahead on "original" development which, as so often before, has been anticipated in Nature's workshop.

With the bat and diptera halteres, science has eventually discovered the secrets of some of Nature's navigational equipment, but with the homing pigeon and migratory birds generally, scientists and ornithologists are still seeking the explanation for birds' strange and wonderful powers of navigation over short and long distances. Many theories have been advanced, but these generally can be backed only by inconclusive tests, and the supporters of the various theories are almost violent in their mutual disagreements.

Navigation for Man is a complicated task. Navigator measuring his position with a sextant in the turret of an aircraft.

The most recent of these tests were carried out by Professor H. L. Yeagley in the U. S. A. By fitting magnets and insulators to the wings of pigeons, he endeavoured to demonstrate that the pigeons' homing ability was dependent upon a combination of the vertical component of the earth's magnetic field and the Coriolis force. By finding two places over a thousand miles apart at which magnetic and Coriolis effects were identical, Professor Yeagley tried to prove that a bird would home to the identical but unknown alternative site if sensitivity were tuned on the given magnetic/Coriolis combination during training and settling-in at its home loft. In the event, although many pigeons *did* home to the alternative site on release, many others were lost by trying *not* to reach the alternative territory but to return to the home loft, or were physically upset by the unnatural addition of magnets and insulators and few biologists and

Man has still not penetrated the secrets of bird navigation.

How does the homing-pigeon find its way back to the loft?

Who shows the Arctic Tern the way from Alaska to the Antarctic?

What secret force enables the albatross to pick out his own small island after flying thousands of miles across the ocean?

physicists outside America agree with the Professor's opinion that anything conclusive was demonstrated. In any case, it would be difficult to apply this theory to the long-distance navigation by migratory birds, always assuming that their navigational equipment is similar to that carried by the homing pigeon.

Professor Yeagley's theory is, in fact, an extension and modification of that held by the Swedish Physicist Professor Ising, which gained much support in the British and U.S. Army Pigeon circles during World War II. This explanation is that the homing bird determines its latitude and flight direction relative to the great circle of longitude by the sole aid of the Coriolis force. The bird is supposed to determine this position through swirling motions created in the semi-circular canals of its ear by the action of this force. Here the argument against this conclusion, as with the magnetic force, is that the Coriolis force is of too small an order for such acute detection and interpretation to be possible; there are other objections, both practical and biological, and the mere fact that the homing ability of a pigeon apparently disappears with the plugging of its ears is more probably due to the physical discomfort upsetting its delicate and sensitive nervous system.

At the Cavendish Laboratory, Cambridge, Dr. A. H. Williamson, physicist, has also conducted considerable research into the navigational abilities of the homing pigeon. He deprecates both the magnetic and Coriolis theories, and supports his own theory of latitude-homing by the sun. This suggests that a homing bird navigates its course by the height of the sun to the latitude of its loft or nest, and then locates the exact spot by search over familiar ground. This might conceivably apply to the pigeon, which can only home over comparatively short distances within a possible search area at night which must not be total dark, but the theory does not explain how the Alaskan Arctic Tern, for instance, reaches the South American Antarctic, where navigation by the sun would appear to present difficulties, nor why nocturnal birds like the British Shearwater or the American Leach's Petrel possess homing powers at least comparable with those of the day-flying homing pigeon. In any case, the pigeon does not climb above cloud to see the sun when homing in daylight in 10/10ths overcast, and neither homing nor migration is necessarily or even usually along a north-south line, while east-west flights are too long for purely visual routing.

It has been pointed out that pigeons, and, of course, other birds are frequently buffeted off their course by cross-winds which would prevent their following any given magnetic or Coriolis directed course, and that when they over-fly their destination in such conditions, they fly back by some obscure "territory sense." But it might be equally true to say that they fly along a parallel magnetic and/or Coriolis line, and after over-flying return along the correct parallel reciprocal. Some authorities assert that homing sense is not affected by radio and radar transmissions or by the proximity of high-power cables, which would be expected to over-ride the low-order magnetic influence, while, on the other hand, a Canadian investigator has recently claimed to have deflected the flight of ducks by using a Radar beam, and others agree that homing birds of all species become confused and put off course by high-powered radio transmitters.

Despite all the theories deduced from the wide research and many tests, the scientists are not very much nearer to deciding the main question of how pigeons home. This failure is probably due in large measure to the unnatural conditions necessarily imposed on the bird by the nature of the tests, but, apart from this, the fact remains that it is not known how the Golden Plover navigates the 3,000 miles from Alaska to the Hawaiian Islands without landmarks to guide it, nor how the shearwater returns to its same niche in the rocky coast, or the albatross returns to its own little island after its ocean cruises of a thousand miles or more. It will probably require Man's discovery of some "revolutionary" navigational system through which the mysteries of homing and migration can be solved, just as with the bat and the diptera, where Man becomes enlightened very much after the event.

You Can't Keep a Good Man Down!

Every now and then we read of quite astonishing feats performed by people who have learned their skill-"out of books." A well-known Danish astronomer, who exercised a kind of fascination over new stars, so that they unhesitatingly revealed themselves to him, was in every-day life a farmer and cattle-breeder. One of Britain's most successful statesmen taught himself painting in his spare time... and today his pictures go like hot cakes (another well-known case, this time of a painter turned amateur statesman, did not have such a happy ending).

*

English penal institutions, like all others in the world, have their exact rules on what is suitable reading matter for their inmates. Their books, like their physical diet, must be solid and sustaining, but not too highly flavoured, and whenever possible "help to develop the reader's capabilities and prepare him to earn his living outside."

For 19-year-old Brynley Fussel the library of his reform school at Rochester (Kent) held a great attraction. Every Saturday he fetched himself a book on flying. In his spare time, when the thoughts of his more dull-witted companions rose no higher than eating, sleeping and suchlike, he devoured all the flying books he could lay his hands on. Then one Tuesday he was ready. He lagged behind the rest of the team and the warders when they were returning from their outdoor work. When it was dark he jumped over the hedge and made his way to Shoreham airfield.

It is no particular achievement for an expert to roll a stolen "Auster" out of the hangar. But to turn the propeller, switch on the ignition, start up, open the throttle—all completely alone—only the self-taught genius can do this successfully. Brynley's engine recognised the master touch, and sprang into life.

The expert Blériot crossed the channel in bright sunshine and only had to take off and land once. Brynley's first take-off was made at three o'clock on a cloudy November morning. Ten minutes later he came down again, so as not to lose his way in the dark. Later he took off a second time, flew over half of France without once getting lost, and finally brought down "his" aircraft in a tree-bordered field outside Péronville near Orleans. The aircraft was undamaged but for the propeller.

The prison ideas on suitable reading had certainly borne fruit. By "developing his capabilities" it had undoubtedly helped prepare Brynley Fussel to "earn his living outside." His French lawyer, Maître Legros, gave it as his opinion that for Fussel to be "kept in" for six weeks or so would be sufficient punishment and that afterwards it surely would not be difficult to find a job for "such remarkable talent."

*

Brynley was found by the French police the next day at a garage. But where is the Australian police to look for an amateur who has made off with a 14-ton rocket which weighs four tons even when empty?

After long discussions the Committee of the Sydney Exhibition had succeeded in getting the loan from Woomera rocket proving ground of one of the giant rockets which go whistling over the Australian desert and the Pacific day after day.

It happened on the way to Sydney, just beyond Broken Hill. If the rocket is not already on the way to the moon, the finder is requested...

Book Reviews

Einführung in die Technische Thermodynamik (4th edition), by Dr. Ing. Ernst Schmidt. — Springer-Verlag, Berlin - Göttingen - Heidelberg, 1950.

The *fourth* edition of this book, one of the best-known text-books on thermodynamics in German, contains a number of amendments and additions. In particular there is a new section on jet engines and a description of jet propulsion in its various applications (Lorin duct, jet turbine, rocket). The book also includes an outline of chemical thermodynamics, with special reference to combustion processes. Lists of contents, tables, formulæ, index of names and subjects and practical problems (together with their solutions) supplement the text and make this work of inestimable value to both student and practical engineer (German). *Ba.*

Handwörterbuch der Meteorologie (Meteorological Dictionary), by Dr. Karl Keil. Published by Fritz Knapp, Frankfurt am Main, 1950.

Approximately 3500 German technical expressions connected with meteorology and related sciences are arranged here in alphabetical order with concise definitions and bibliographical notations. A tremendous amount of work has gone into the preparation of this book, which will provide valuable assistance not only for the meteorologist, but also for those concerned with transport—in particular air transport and shipping—agriculture, sport and medicine, not to mention daily and specialist journals. There is scarcely any sphere of human life which does not depend on the weather! The definitions are so worded that they can be understood without specialised knowledge. Later editions could perhaps give a more detailed account of some of the chief concepts or illustrate them more profusely. Nevertheless the book is well fitted to give the enquirer an initial answer to his problems. The compiler was for many years instructor at the German School of Meteorology (German). *Ri.*

Blue Book of the Vliegtuigbouwkundige Studievereniging "Leonardo da Vinci" — published by the Association, Delft, 1950.

To celebrate their fifth anniversary the Association of Aviation Students of the Delft Technical High School has published a commemorative review in the form of a Blue Book. In addition to reports on the past activity of the Association and a tribute to the pioneer after whom it has been named, it contains articles on the Dimensions of Monocoque Construction Units (Prof. Dr. Ing. A. van der Neut), Calculation of Helicopter Performance (J. Meijer Drees), Examination of the Landing Process in Transport Aircraft (J. G. ten Asbroek), Wind Tunnel Measurements of Models with Rotating Propellers (J. A. Landstra) and Investigation of the Flying Qualities of Swept Wings and Delta Wings (D. J. Reuselaars). Each article has an extensive bibliography (Dutch). *Ri.*

Books Received

(to be reviewed later)

Fascicules du Centre belge de Navigation. — Distribution through the Office de Publicité, Brussels:

No. 1. *Aspects météorologiques du problème du vol optimum*, by Prof. J. van Mieghem.

No. 2. *Analyse des travaux des fondateurs de la théorie du vol optimum*, by Prof. F.-H. van den Dungen.

No. 3. *Sur la représentation plane des lignes d'égal azimut*, by A. Gougenheim.

No. 4. *L'adaptation des turboréacteurs aux diverses conditions de vol*, by A. Jaumotte.

No. 5. *Optimum Flight Paths*, by D. O. Fraser, and *Les zones de turbulence de la Troposphère moyenne et supérieure*, by Prof. J. van Mieghem.

Publications scientifiques et techniques du Ministère de l'Air — distribution through the Service de documentation et d'information technique de l'Aéronautique, Paris:

No. N.T. 37. *Application précise d'une clause qualitative de régularité au dépouillement des courbes expérimentales et à la solution de certains problèmes mathématiques*, by Pierre Vernotte.

No. N.T. 38. *Note sur une représentation rectiligne des hyperboles sphériques*, by P. Hugon.

No. N. T. 39. *Contribution à l'étude de la surface des solides pulvérulents*, by F. Laporte.

The Mind of Mr. Reader

Dear Sirs,

I have only just seen, with very great interest, your Issue No. 10 of *Interavia*, which is devoted almost exclusively to astronautics. I should like to congratulate you on the excellent production of this number, and to express the thanks which all workers in astronautics must feel to be due to you for your very sympathetic treatment of our interests.

The discrepancy between, *e.g.*, the Sanger and Himpan values for theoretical exhaust velocity seem to have puzzled your editorial staff, as they have often done to others before. The true explanation lies in the quite legitimate, but very confusing, use of this same term for two quite different quantities, by different writers.

By "theoretical e.v.," some mean the value which would result *if* the entire calorific value of the propellant mixture concerned could be converted into jet kinetic energy. This quantity is of little more than academic interest, and is much higher than the practically realisable values.

Other workers use the term to mean the value which would be given by the given propellant mixture if its gaseous products are expanded over a given finite, pressure range, assuming that there are no losses from imperfect combustion, nozzle friction and shock, etc. Since these losses are small in practice, the "theoretical e.v." defined this way is close to the practical value. It is the figure obtained from a calculation assuming adiabatic expansion in the nozzle, with due regard to the specific heats, molecular weights, etc., of the particular gases resulting from the propellants in question.

Incidentally, the technical workers of the B.I.S. do not agree with the implications of Himpan's article, regarding the possible future use of nuclear energy for rocket propulsion. He is quite right, of course, that propellant density *is* important, but there are more considerations involved than he concedes.

You probably feel (quite understandably!) that you have devoted quite enough space to astronautics for a while, but if you ever do want to re-open these questions, you might care to consider an article from some B.I.S. technician—I believe we could furnish you with an accurate and stimulating article, if you so wish.

In the meantime, you may be interested to see the enclosed examples of our current publications.

Very sincerely yours,

A. V. Cleaver, Chairman of the Council,
The British Interplanetary Society.

22, Lyndhurst Gardens, Belsize Park, London, N.W.3, ENGLAND.

Operation "Aerial Super"

A New Zealand Experiment in Farming

BY V. S. SWAMINATHAN, LONDON

Typical New Zealand hill country in which aerial fertilising is both cheaper and more uniform than older fertilising methods. Trials were held over this type of country. Highest ranges in this area are about 2,000 feet.

Today, in a world still short of food and the Sterling area still critically short of dollars, New Zealand farmers are going all out to increase food production in their valleys, hills and lowlands. This British Dominion is one of the first countries in the world to plan and put into operation aerial farm aids on an impressive scale.

Five factors account for New Zealand's venture into operation "Aerial Super," *i.e.*, high productivity of the country's soil provided that fertilisers and vital trace elements like cobalt and manganese are available; a terrain largely mountainous and rugged; imperative need to check soil erosion in the hilly country; the part the country is committed to play in Pacific and Commonwealth defence; and enthusiasm of the farmers.

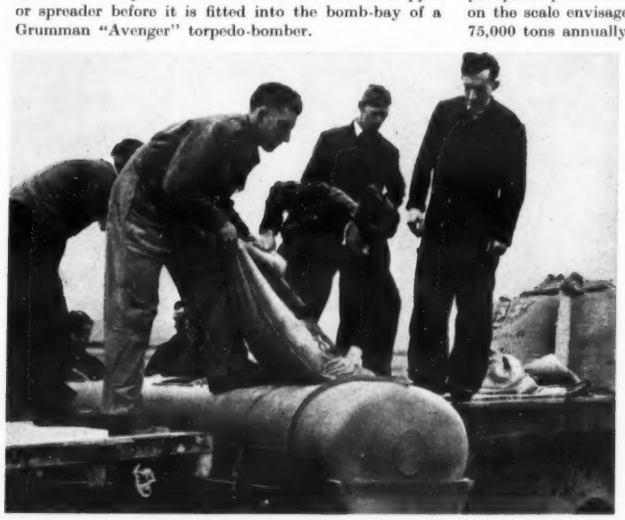
As elsewhere, first aircraft trials in New Zealand were applied to seeding and to light lifts for special purposes. The latter included dropping of supplies and ammunition, and even prepared timber-and-roofing huts to State deer riflement in inaccessible mountainous country, where imported deer have multiplied rapidly to constitute a serious menace. Also, the proliferating rabbit has been fought with some success by spreading poisoned pollard by light aircraft.

Animals feeding on "bush sick" soil pastures of the Dominion, because of cobalt deficiency, began to languish. Such soils have been rendered healthy by spraying cobalt solution from 120 feet over vast areas. In addition, promising work is being done in rough sowing with lupin to stabilise shifting coastal dunes. The New Zealand Soil Conservation Department has found that aerial transport of willow poles required to stabilise slipping country is cheaper than by pack horse.

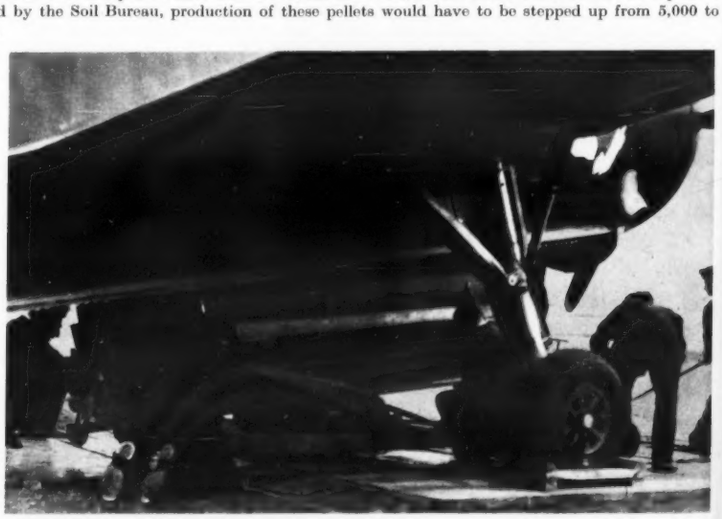
Over the five long and critical years from the fall of France to the end of the last war two-thirds of Britain's entire butter ration and half of her imports of lamb, mutton and cheese came from New Zealand, which shipped to the Mother Country 1,327,609 long tons of meat, 685,505 tons of butter and 598,874 tons of cheese.

The hill lands of New Zealand form sheep and cattle areas *par excellence*. Today labour is at a premium, the grass cover has become thin and the hill lands are both declining in productivity and sliding down. Sown grasses hold to 3,000 feet, and above that level are found the sparser native hussock grass. Following comprehensive land and aerial surveys, an interdepartmental committee, consisting of representatives of Land and Soil Conservation, Scientific and Industrial Research, Civil Aviation and the Royal New Zealand Air Force, reported that there are ten million acres below 3,000 ft. level, which, if top-dressed with phosphatic fertiliser, could be doubled in carrying capacity, from one to two sheep per acre. In other words, ten to twelve million sheep could be added to the Dominion's 32.5 million sheep, the two million beef cattle increased to three million and £20,000,000 added to yield from exports. Moreover, these precious hill sides could be saved for posterity from the ever-present menace of soil erosion.

Air Force men pour fertiliser from sacks into the hopper or spreader before it is fitted into the bomb-bay of a Grumman "Avenger" torpedo-bomber.



The spreader, containing a ton of superphosphate, is adapted to the bomb-bay of the "Avenger." Coarse-screened phosphate pellets about the size of a peanut have been found the most suitable for aerial distribution. To top-dress on the scale envisaged by the Soil Bureau, production of these pellets would have to be stepped up from 5,000 to 75,000 tons annually.



Canvas check traps, one square yard in area, are arranged in a series of parallel lines over part of the course. From the pellets recovered the experimenters are able to calculate the distribution per acre and the effect of wind deflection.

Collecting superphosphate pellets from the check traps for weighing following aerial distribution.

That heavy lifts of phosphatic fertilisers are both feasible and economical was demonstrated by a series of tests recently concluded on the hill lands fifty miles north of Wellington. The 100 acre block trials have shown that aircraft score over man on cost and on more even distribution of fertilisers over ridges and valleys. From 400 ft. above hill top levels an aircraft carrying one ton of fertiliser top-dresses just under 10 acres in a swathe half a mile long and 130 feet wide, the actual release time being 15 to 18 seconds. Flying at 1,000 ft. on parallel lines, directed by ground control parties on radio jeeps or with walkie-talkies, ten-tonners dress 100 acres per take-off.

For these tests, hoppers were fashioned from extra fuel tanks, with loading hatches cut above and chutes and discharge slots below. They were filled from hogs manhandled into position and lifted to the bomb bay with adapted bomb transporters. A total of 137 long tons of fertilisers was thus distributed over 1,088 acres within a radius of 20 to 30 miles in an aggregate flying time of 57 hours 10 minutes. The cost of applying 2 to 2¼ cwt of fertiliser to an acre worked out to about 15 shillings. Within a week of the conclusion of these demonstrations the New Zealand Federated Farmers had in hand applications in respect of 248,715 acres of hill lands.

It is stated that an aircraft like the Handley Page "Hastings," with special quick-release panniers, would prove eminently suited to aerial top-dressing without detriment to their military effectiveness. This method would at one stroke lead to increased food production, serve to reclothe "mined" hill lands, and offer exceptional opportunities for precision training of air communications and ground sections of air force personnel. Although there are ten million acres of hill lands in New Zealand likely to respond to top dressing, the present intention is to limit initial expansion to 750,000 acres a year.

Before launching large-scale aerial top-dressing operations, certain hurdles will have to be negotiated. Additional capacity for super-phosphate production in pellet form is necessary. More work remains to be done on the most desirable form and weight of "Aerial Super." Fused triple superphosphate is stated to offer great possibilities, in cutting distribution costs. For economic reasons fertiliser mills are best located near aerodromes.

The 100-acre trials and earlier tests with light aircraft indicate that the optimum radius for light machines (lifting 6-10 cwt) is five miles and upwards; for one-tonners, 20 to 30 miles and for ten-tonners, 40 to 50 miles. Before large-scale aerial land treatment can be undertaken means must be found for every farmer to be "in," since 100-acre swathes of falling fertiliser (superphosphate or lime) cannot be broken to miss the small man, who, for financial reasons, may be compelled to remain out of the scheme. This entails evolving some system of finance carrying low interest rates.

The New Zealand Government has already announced reductions in price of locally manufactured fertilisers, subsidies of £4 a ton on imported slag and £3 a ton on imported gafsa with unrestricted import licences and the setting up of the first of a series of new fertiliser works in Hawke's Bay district. Large quantities of lime will also be needed, and aerial top-dressing must be followed by similar fresh sowings of grass seed.

The New Zealand Government and the Soil Conservation and Rivers Control Board are embarking on this big scheme for rejuvenating large tracts of mountainous countryside by aerial distribution of fertiliser and seed. It will be carried out by the R.N.Z.A.F This daring concept is a combination of air force training and maintenance for regular Service operations, with food production and checking of soil erosion as two other major aims. Results of this large-scale experiment will be watched with interest by other countries with similar problems to solve.

The "Avenger," flying between 400 and 500 feet above the hills, spreads a 100-ft. wide path of fertilizer at the rate of two hundred-weight an acre.

Military Medicine Sprouts Wings

BY RICHARD LACOSTE, WASHINGTON, D.C.

A new day has dawned for American military medicine. Train transport and slow-moving ships hitherto used to move the ill and wounded are on the point of being relegated to their proper place in history—the past. Modern military medicine literally has sprouted wings.

Today, on that land mass that is the Korean peninsula, American sick and wounded are picked up by helicopter in combat areas and airlifted to the rear for immediate attention. They then are flown to the United States. In many instances, fewer than 60 hours elapse from the time a man is wounded and his arrival at a hospital near his home.

During June of this year, 300 sick and wounded were airlifted from the Pacific area to the U.S.; in July there were 535. And during the month of August more than 900 battle casualties were flown back to the United States. The monthly totals have gradually increased ever since. Once the sick and wounded are returned to the United States, they are flown to the military hospital specializing in the type of treatment needed. The disposition of Army and Air Force patients is determined by the Army or Air Force Surgeon General when the patients arrive in the U.S. Navy patients are sent immediately to the Navy hospital nearest the port of debarkation. Whenever possible, patients are flown to the service hospital nearest their homes.

This is the status of American air evacuation today.

Yet, as late as October of 1949, many military medical patients were moved by hospital ships and train. The U.S. Army Transport "Comfort," formerly on the trans-Atlantic crossing, completed its last sailing at the end of September 1949. A hospital train, which formerly distributed patients to government hospitals in the U.S., also has been taken out of service.

"This was a peace-time policy placed into effect by the Secretary of Defense," reports Major General Laurence S. Kuter, commander, Military Air Transport Service (MATS). General Kuter currently heads the organization that moved more patients over more mileage in less time during World War II than any other service or country in the history of world aviation (cf. details of MATS, *Interavia Review* No. 11, 1950). His also is the responsibility of air evacuation of wounded United Nations' individuals in Korea.

The American armed forces are proud of the record established by military medical men. The lives they saved, the services they rendered and the standards they set forever will stand in tribute to their courage and foresight.

During World War II, American servicemen received better, faster and more efficient medical treatment than even medical men believed could have been possible in times of stress, under trying conditions, in all climes.

The report of military medicine is a stirring story of selflessness, self-sacrifice, devotion to duty, and accomplishment. Likewise, it is a story of the profession's progress. Lastly, it is an undeniable proof of man's humanity to man.

Today, two modern miracles—aviation and medicine—have joined hands over the vastness of the world's areas to bring a new hope for life and a lessening of suffering to the military ill and wounded.

We have indeed progressed far from the days when the wounded were left where they lay. In contrast, during World War II, wounded were picked up, carried to first-aid stations, frequently air-transported to modern military hospitals in less time than it took the medieval soldier to languish to his ignominious death on the battlefield.

In Korea today the policy is air evacuation of the wounded—one hundred per cent.

Does the new programme mean the end of surface transportation for American wounded? Not exactly. The services still would need ships and hospital trains in times of emergency greater than the Korean crisis.

But the policy underscores the demands of the air age. It presages progress for military medicine—both in war and in peace. It makes for better morale. It saves lives.

Military tacticians and logisticians, too, are vitally concerned with air evacuation. As non-effectives are withdrawn from scenes of combat, a new factor enters into their calculations. Tacticians and logisticians both will weigh this new factor in their approach to the science of war.

Air Evacuation, World War II

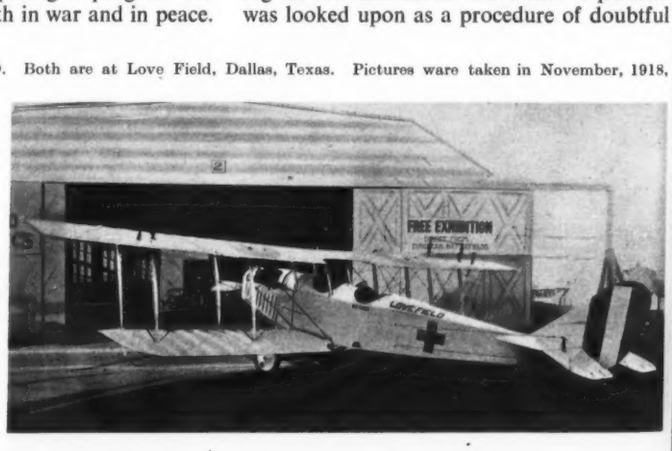
Perhaps the most dramatic—certainly the most progressive—phase of military medicine during World War II, and now in Korea, is the speed of air evacuation of the wounded from forward areas to modern up-to-date hospital facilities in a matter of hours.

Although plans were proposed for the development of air evacuation at the onset of World War II in Europe in 1940, they were not activated until November 1942. The War Department then directed the Surgeon General to train flight surgeons, flight nurses and enlisted medical personnel for air evacuation duties. Late in 1942, however, the need for aircraft of all types became so acute that planes could not be used solely for air evacuation. The Army Air Force therefore adopted the policy that troop carrier and air transport planes would be utilized for air evacuation as a secondary mission.

Through 1942, '43 and '44, a School of Air Evacuation trained medical personnel for this type of work. As squadrons were activated, organized and trained, they were assigned to the various theatres and to the Air Transport Command. By 1944, every theatre had been assigned air evacuation personnel quotas.

During World War II the Army Air Force moved approximately 1,360,000 patients by air. This figure included patients evacuated from forward medical installations, from theatres of war to the Zone of the Interior, and from one hospital in the U.S. to another for more specialized treatment. Considering the fact that the air movement of patients was looked upon as a procedure of doubtful

Two of the U.S. Army's earliest ambulance aircraft. *Left* is a JN-44, *right* a JN-4D. Both are at Love Field, Dallas, Texas. Pictures ware taken in November, 1918, World War I Armistice month.

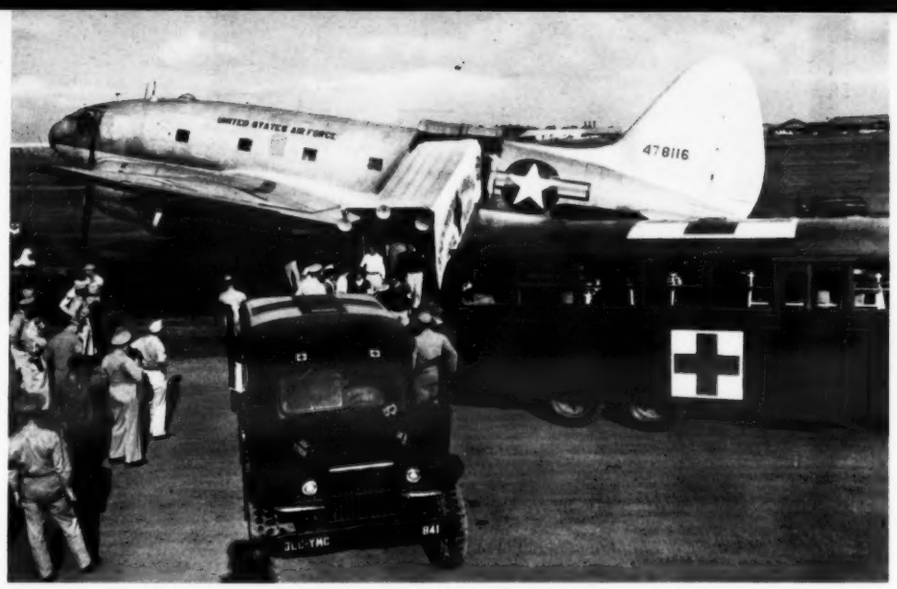


Slow-flying helicopters afford the speediest evacuation service on the Korean war front. The soldier's litter is fastened by special attachments to the side of the Sikorsky helicopter which, with another patient on the other side, will take off for a rear-line hospital. Helicopters are sent out only for the most critically wounded. A ventilated plastic canopy covers the litter.

A U.S. Medical Corps man ministers to a wounded GI during the flight from the Korean battlefront to a hospital in Japan.

Steve Migoley, of New York City, the first casualty to be evacuated from captured Kimpo airfield since its recapture from the North Korean Army, gets a light from Flight Nurse Lt. Valerie P. Cigagna, of Spencer, Ohio.

Huge four-engined Boeing C-97 "Stratofreighter" hospital aircraft fly severely wounded soldiers from the Far East to the United States. Picture shows three of the 70 soldiers aboard a C-97 of MATS as they begin their trip to Hawaii.



Medium-size transports carry the wounded from rear-line hospitals to base hospitals in Japan. Picture shows former American prisoners of the North Koreans, liberated by the U.N. forces, arriving at Tachikawa Air Force Base en route to various Army hospitals in Japan. The aircraft is a Curtiss C-46 "Commando."

value even as late as 1943, this tremendous airlift is a great tribute to the U.S. Air Force and the air evacuation personnel who made it work.

Medical men all over the world agree that World War II air evacuation, perhaps more than anything else, revolutionized military medicine and propelled the air transport industry another step forward.

Early Air Evacuation

Actually, air evacuation was conceived soon after the Wright Brothers invented the airplane in 1903. As in the case of all such inventions, a few farsighted men with vision and faith in the future foresaw the possibilities of transporting the sick and wounded by air. Early efforts to use the airplane for this purpose, however, were regarded neither as safe nor practicable.

The first known plane to air-evacuate patients was proposed by American military officers in 1910. These officers had constructed a plane at Fort Barrancas, Florida. They made their first flight in 1910.

Captain George H. R. Gosam, Medical Corps, U.S. Army, asked the U.S. War Department for funds to improve his plane and use it for carrying medical supplies and patients. He failed in his mission. Gosam undoubtedly was the first military medical man to point out the possibilities of aircraft for this purpose. Although two years later the use of airplanes for the transportation of patients was recommended to the Secretary of War, the airplane was not deemed sufficiently safe for such use.

Army medical history credits Major Nelson E. Driver, Medical Corps, and Captain William C. Ocker, Air Service, with air evacuation of the first patient in the U.S. In 1918, Driver and Ocker converted a JM-4 airplane into an ambulance aircraft at Gerstner Field, Louisiana.

A French doctor is believed to have invented the first airplane ambulance ever used. Appearing before the French Chamber of Deputies in 1917 he pleaded for funds to finance an air evacuation project. His request was rejected with the statement that there were enough dead in France without killing the wounded in airplanes. Pioneer that the French doctor was, he used his own airplane on the Amiens front.

The first American ambulance plane was devised also during World War I, and was

Litter patients are hoisted on to the hospital aircraft by this special litter lift.

An ambulance and fire truck stand by while the engines of the MATS medical air evacuation aircraft (in other words, a C-97 hospital plane), warm up before moving out to the take-off strip on its way from Tokyo to the States.

placed in use at Lake Charles, La. Still, over the years, air evacuation progress continued pedestrian. As late as 1921 the War Department ruled that "...the use of airplanes for the transportation of sick and wounded, when other means of transportation is available, can not be justified."

During the years that followed, flight surgeons crusaded for this modern method of transportation. Whenever possible they used air transportation for military patients. Light planes usually were employed for this purpose.

First Mass Movement

Meanwhile, allies and enemy alike progressed rapidly in developing air evacuation to a high degree of efficiency. During the Spanish Civil War, the German *Luftwaffe* evacuated casualties via Italy and over the Alps to German university and military hospitals. In contrast to the many days that would have been required for other modes of travel, these 1500-mile flights were made in ten to twelve hours. The Italians, during this same period, are reported to have used air evacuation to a lesser extent. That the Germans considered the Spanish Civil War a "dress rehearsal" for future activities is indicated by the meticulous medical records kept of their air evacuations. They even experimented with their casualties by flying as high as 19,000 feet.

By September 1939, when the Germans smashed their way through Polish barriers, the *Luftwaffe* was ready for air evacuation on a large scale. In that first month of the Blitzkrieg through Poland, approximately 2500 German casualties were air-evacuated. In the first two years of war the Germans evacuated more than a quarter of a million patients by air from the eastern front and the Balkans and from the uninhabited vastness of the Russian plains.

British, Canadians, Australians and French also used air evacuation to a greater or lesser degree prior to and during World War II. To the Russians, because of their extended battle lines, it proved to be a boon.

Air evacuation became an American military necessity early in 1942 during the building of the Alcan Highway to Alaska. Almost simultaneously, air evacuation requirements developed world-wide. For a period of two years, however, shortage of planes and trained medical personnel precluded the development of required air evacuation.

Pacific Air Evacuation

American military planes participated in the first mass movement of patients in March 1942 during the Burma-Java Campaign. In a ten-day period 1900 sick and wounded soldiers were moved from Myitkyina to Dinjan, Burma. Ten Douglas C-47 "Skytrains" were used. Although 24 litter (stretcher) cases is the comfortable maximum for this type of plane, 74 patients were crowded into one "Skytrain" on one trip. Another early large scale evacuation was prompted by strategic necessity. At the beginning of the autumn of 1942 the Fifth Air Force transported patients from Buna, New Guinea, over the Owen Stanley Mountains to Port Moresby into Australia. On other occasions tactical necessity dictated air evacuation of the ill and wounded. This was true in such offensives as those on Tarawa, Saipan and Guam where battle areas were crowded and medical facilities limited. In many cases there was one of two choices—air evacuation or death.

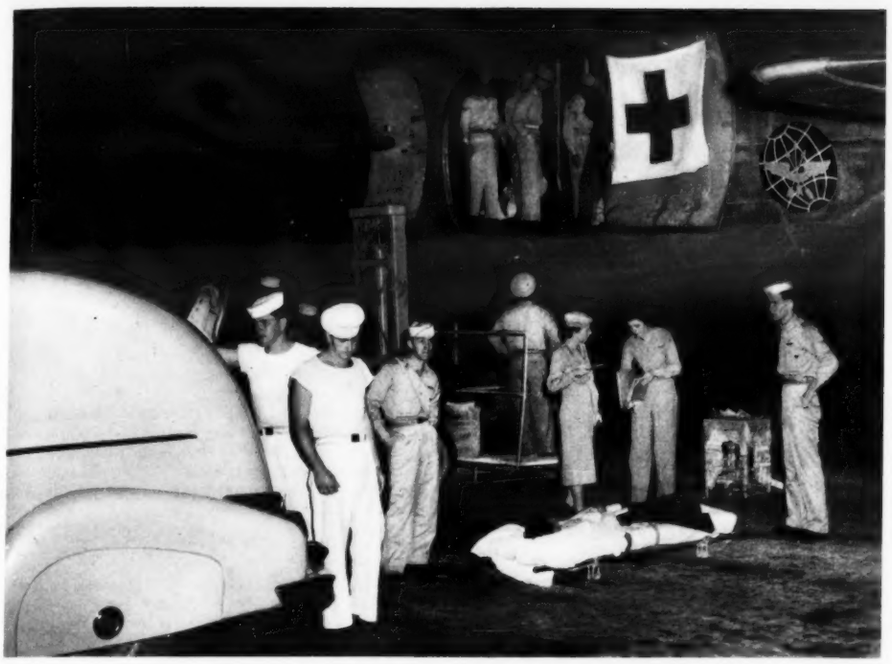
Logistics and Tactics

In these post-war days, conservation of critically scarce medical personnel, consolidation of medical facilities and morale were points advanced in favour of changing from surface transportation to world-wide air evacuation. In times of war, logistics and tactics will *require* maximum air evacuation of the ill and wounded.

From the standpoint of logistics, casualty evacuation will become increasingly necessary as surface routes to the rear are needed for forward movement of reserve forces. Thus air evacuation is the only answer to the evacuation problem which has perplexed military commanders since the day of spear and shield.

Air evacuation is conceded by all factions to be the speediest method of removing non-effectives from the combat area. Its tactical value was proved at Tarawa, where the necessary limited combat area hampered military operations. A similar situation developed in New Guinea. There, in the mosquito and fever-infested jungles the only means of transportation were afoot or on pack animals over the Owen Stanley Mountains. Incidentally, all casualties in those two areas were air evacuated.

A Douglas C-54 "Skymaster" ambulance aircraft of MATS moves out to the runway at Haneda, Tokyo, for its first trip to Guam and the U.S.A.



Flight Nurse Captain Marjory O. Horton (centre, no hat) reports and transfers the medical records of the arriving evacuees to Flight Nurse Lt. Flora E. Manahan, who is in charge of the medical evacuation duties at Guam. This is a typical scene of a night arrival and rest stop-over of an evacuation flight.

Air Evacuation Vs. Surface Transportation

How does air evacuation compare with surface transportation? Eight and one-half tons of supplies, for instance, are required to maintain one man overseas for the first 30 days. Thereafter one and one-half tons for each man is the ratio of supplies needed for his maintenance. This maintenance of a supply line forever is a pressing problem for an overseas commander who would welcome evacuation of non-effective personnel.

The tremendous traffic of supplies required to maintain non-effectives overseas might in the future seriously hamper commanders in the accomplishment of their missions. That is why so much thought today is given to air evacuation problems.

A World War II study of air evacuation revealed that to transport 550 wounded patients from England to the U.S. would require the use of one hospital ship for 45 days. Three airplanes could accomplish the same mission in the same period of time. But 30 planes could accomplish this evacuation in exactly three days.

The advantages of air evacuation are many. For one thing, the time saved means additional lives saved. Some of the other advantages are :

1. Fewer and smaller holding hospitals abroad are required.
2. Fewer medical personnel in attendance abroad.
3. Fewer vessels diverted from combat supply to air evacuation duties.
4. Fewer vessels diverted to supply of hospitals and medical personnel abroad.

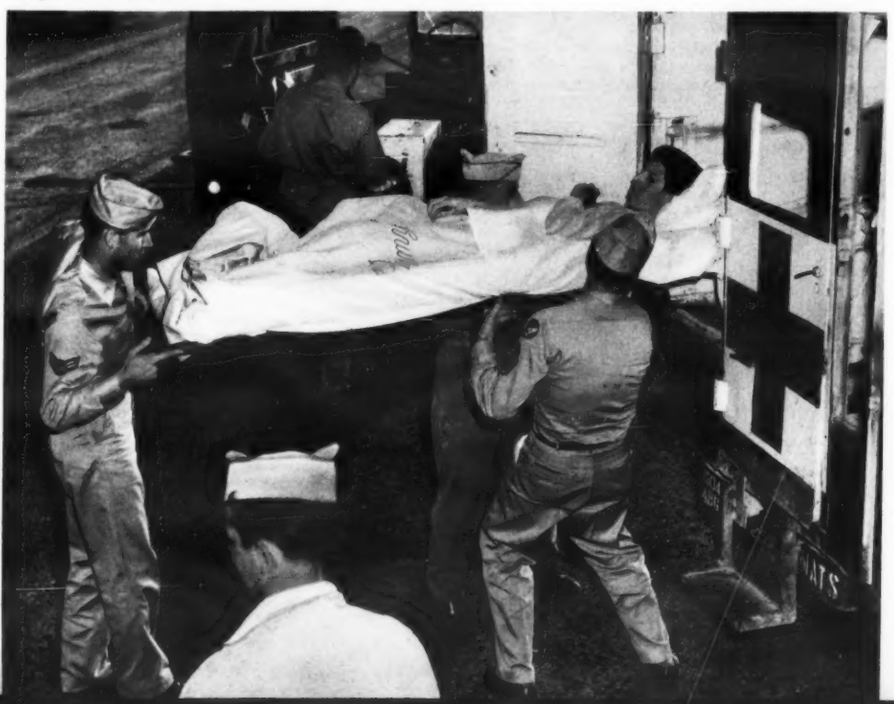
A study of the logistical advantages of air evacuation by the Office of The Air Surgeon during World War II indicated that 14 Douglas C-54 "Skymasters", each equipped with 24 stretchers, could do the job of six 500-bed hospital ships in carrying 3,000 patients at the rate of 1,000 a month from the Southwest Pacific.

The purchase cost of the airplanes then was $5,352,578 compared with approximately $24,000,000 for the hospital ships. The total personnel involved, including ship or airplane crews and medical personnel aboard the ship or airplane and in overseas holding hospitals, would be 2,346 by water and 516 by air. Over a three-month period, the total salaries for these personnel, not including bonuses for civilian seamen, was $783,148 by water and $229,344 by air. A 750-bed retaining hospital weighing 1,047 ship tons crated was required overseas for evacuation by sea as contrasted to one 500-bed retaining hospital and three 50-bed in-transit holding hospitals weighing 678 ship tons in the air evacuation operation. The total rations required for personnel and patients involved in hospital ship evacuation was 1,321 ship tons compared with 319 ship tons for air evacuation. The travelling time from the Southwest Pacific was 24 days by water and 39 hours by air. In addition to numerous other items of savings, the C-54 could carry all types of military cargo on the way overseas whereas the pay load of the hospital ship was limited to medical supplies.

Commercial air transport men even today are casting covetous eyes towards the revenue that might be obtained from the carriage of the sick and wounded. Medical centralization makes civilian air transport of hospital cases a highly practical potential. Regularly scheduled flights to world-renowned medical centres are a definite probability.

Twelve combat-wounded from Korea tied on stretchers in a C-97 cargo aircraft. Flight nurse is Lt. Constance Cowette.

Casualty being lifted into an ambulance at Guam after arriving from Tokyo. After being fed and cared for during the hour-and-a-half stop at Guam, the patient will continue his evacuation flight to the States after stopping at Kwajalein and Hickam.



What's in the Air?*

AIR TRANSPORT GOES ON, IN SPITE OF INTERNATIONAL TENSION.

The dangers of the international situation and the shortages appearing on the raw materials and labour markets as a result of the rearmament programme, have not yet had any adverse effect on air transport. On the contrary the traffic figures for the ten months up to the end of October published by 16 leading *inland air transport companies in the USA* show a rapid upward trend. During these ten months more passenger/miles were flown than in the whole of 1949 (*1949*: 6,562,580,000 passenger/miles: *1950*: first ten months: 6,563,846,000 passenger/miles). Provided there are no unforeseen reverses in November, December, American air transport can anticipate an increase of at least 20% in traffic for the whole of 1950. And—which is no less gratifying to the promoters—net profits appear to be keeping step with operating performance. A total profit of $50,000,000 for the year is forecast for the same 16 American companies, compared with $23,550,000 in 1949 and an average annual loss of $8,000,000 during the three post-war years 1946-1948.

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Some of this success is reflected in European air transport, in particular by the previously sorely-tried *British concerns, BOAC and BEA.*

Back in Great Britain after a three-week tour of inspection of British overseas services, Sir Miles Thomas, Chairman of BOAC, said on 9th November: "I am well satisfied with the improvements being made in our dollar-earning North American organisation. For two months now our New York-London service has been running at a profit and last week we carried more passengers from Canada to Europe than any other airline." This satisfying news forms a fitting complement to BOAC's announcement in September that an overall operating profit had been made for the first time in its history.

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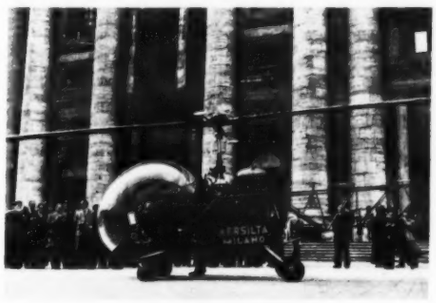
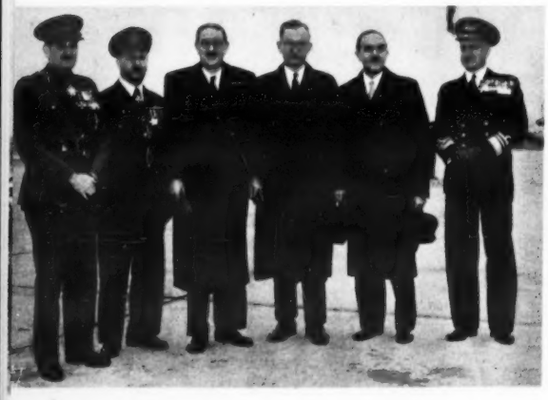
* Extracts from INTERAVIA AIR LETTER, daily international news digest, in English and French. All rights reserved.

John Lankester Parker, one of the directors of the British flying boat constructors Short Bros. and Harland Ltd., (right), receiving the Brackley Memorial Trophy from the *Guild of Air Pilots and Air Navigators of the British Empire* in recognition of his services to aviation. During his 30 years as Chief test pilot at Shorts he flew all their flying boat prototypes. Left: Wing Commander Harold F. Jenkins, Master of the Pilot's Guild; centre: Captain Lawrence A. Wingfield, Clerk of the Guild.



From the sublime to the helicopter.—A Bell 47 D.I. helicopter of the Italian *AERSILTA* air accessories company landing in St. Peter's Square during the Rome Armistice ceremonies on 11th November, 1950.

Jules Moch, French Minister of Defence (third from left) on a visit to Ottawa for talks with the Canadian Government. Lt. Gen. Charles Foulkes, Chief of the Canadian General Staff and Air Marshal W. A. Curtis, Chief of the Air Staff. Right: Brooke Claxton, Canadian Minister of Defence, Herbert Guerin, French Ambassador to Canada, Vice Admiral H. T. Grant, Chief of the Naval Staff.



Discussions in Canada between the Chiefs of Staff of the Canadian, French and Norwegian air forces. Left to right: *General Charles Lecheres*, chief of staff, French Air Force.—*Air Marshal W. A. Curtis*, chief of staff, R.C.A.F.—Lieutenant General A. Bjarne Oen, chief of staff, Royal Norwegian Air Force.—Group Captain R. A. Cameron, commanding officer, R.C.A.F. Station Rockcliffe (Canada).

The report by Peter Masefield, Chief Executive of British European Airways, is no less promising. BEA made a profit of £200,000 during the 1950 summer season (from 1st June to 30th September. 1950, total profit: £385,618; August and September £134,871 and £134,828 respectively) and has carried over a million passengers during the past 12 months. Masefield added, however, that these good results would be largely offset by expected winter losses.

Finally the Spanish company, *Iberia*, has also operated with remarkable success, having made a profit of 20,000,000 pesetas (before taxation) during the first nine months of 1950. A record achievement in the annals of European air transport, since this operating profit represents over half of Iberia's share capital (34,000,000 pesetas).

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These financial successes are having an encouraging effect on the aircraft purchasing programmes of the various companies. During November Douglas and Lockheed received the following new orders:—*American Airlines* ordered three extra Douglas DC-6Bs, in addition to their earlier order for four of these machines. Deliveries are to start in February 1951, and will increase American Airlines' fleet to 155 aircraft, including 45 DC-6s, 14 DC-6Bs, 33 "Convair-Liners."—The *Scandinavian SAS* has ordered one DC-6B for each of its member companies DDL and DNL. Delivery is expected for early 1952.—The *Dutch company KLM* proposes to replace its long-range fleet of DC-4s and C-54 "Skymasters" by seven DC-6Bs and five Lockheed L-749 "Super Constellations." However, Dr. Albert Plesman, President of KLM has stated that he has reserved the right to cancel his order for two of the DC-6Bs.

SCHEDULED VERSUS NON-SCHEDULED AIR TRANSPORT:

Meanwhile the *conflict between scheduled and non-scheduled air transport operators* continues. On 13th November the American Civil Aeronautics Board initiated hearings regarding applications filed during the summer by two major non-scheduled operators, *Transocean Airlines* and *Seaboard and Western Airlines*, for permission to increase their freight transport to Europe and the Middle East. The CAB examiner earlier recommended that both applications be turned down as being "uneconomic," since the new freight services would offer unwelcome competition to the scheduled trans-Atlantic operators PAA and TWA. That these two large concerns, which since the disappearance of AOA have been undisputed masters over the Atlantic, are bitterly contesting the non-scheduled operators' applications goes without saying.

While American non-scheduled transport continues to be kept on a short lead, entirely different reports are, as usual, heard from Europe. In reply to complaints by British air charter companies, British European Airways, the officially-recognised company for European services, has stated that it has no intention of forcing these out of business. It was not true to say that it was seeking to keep for itself all the profitable inland services.—The service to the Isle of Man (at present operated jointly by Sivewright Airways and Northwest Airlines, two charter companies) was the only one it proposed to take over in 1951. Moreover it welcomed the operation of feeder services by charter companies.—A certain nervousness among European air charter companies is explained by the appreciable falling off in charter business following the regrettable accident to the Air India International aircraft on Mont Blanc, when 40 Indian sailors lost their lives. Passenger traffic since then has been quiescent and prospects of Christmas business are not very promising.

The four-bladed propellers for the new Convair "Turbo-liner" were developed by General Motors. Here they are being fitted to the Allison T-38 2750 h.p. propeller turbine. These full-feathering steel propellers are 13 ½ ft. in diameter and have a self-contained hydraulic unit with electro-mechanical control system.

WAR PREPARATIONS IN THE SERVICE OF PEACE.

As so often happens in human and in particular in aviation history, war is found to be a promoter of civilian technical progress. An impressive example of this is provided by the part now being played by aviation in opening up the Arctic. The USAF and the Civil Aeronautics Administration are to spend more on perfecting the ground organisation in Alaska in 1951 than has ever been authorised before in time of peace. The USAF alone is to spend over $60,000,000 on improvements to its bases at Eielson, Ladd, Eglin and Larson. New radio and radar installations, repair shops and administrative buildings which will serve Alaskan air transport or a more peaceful future, are to be put up.—Boeing B-29s of the USAF have made nearly 400 weather reconnaissance flights to the Pole from bases in Alaska. Naturally the Arctic experience thus gained by the military crews will be available to future air transport operators in the Arctic.

AIRCRAFT INDUSTRY LOOKING FOR LABOUR, RAW MATERIALS AND PRODUCTION PLANT:

The Pratt & Whitney Division of United Aircraft, who have taken on 2,700 men during the past few months and now have a total labour force of 17,500, need a further 10,000 employees for their production programme during the coming year. The labour force of Consolidated Vultee is to be increased from its present level of 11,000 to 14,000 by March, 1951.

On 25th November, North American took over the Naval Industrial Reserve Plant at Port Columbus hitherto operated by the Curtiss-Wright Corp. The whole of Curtiss-Wright's staff has been kept on and is engaged for the moment on making an inventory of the plant. Three groups each comprising 400 mechanics to work day and night shifts are being sought for a newly-erected plant belonging to Aerojet Engineering Corp., one of the most important American firms engaged in the development of rockets and long-range weapons. (The first indication that large-scale production of these weapons is starting up in the U.S.A.).

Even the Luscombe Airplane Co., which up to the time it was reorganised by TEMCO was fighting against considerable odds, has been obliged to take on hundreds of workers so that it can fulfil its subcontracts for Convair (parts for the B-36 bomber).

Fasten Your Belts. The captain of a R.C.A.F. Douglas DC-4M "North Star" helps an American infantryman adjust his safety belt during the airlift to Korea.

Tony Orta, one of Belgium's aviation pioneers, who obtained Belgian pilot's licence No. 51 in 1911 and helped to found Sabena (and its predecessor SNETA), has died in Brussels at the age of 62. Orta belonged to the board of directors of Sabena up to his death.

General H. J. Kruls (right) Chief of the Netherlands Army Staff, inspecting an R.C.A.F. guard of honour on his arrival at Rockcliffe air station, near Ottawa.

As each month passes it gets more and more difficult to find skilled workers, even though the labour force at present engaged is nowhere near the peak reached during the war. According to a statement by the American labour bureau the number of persons employed in the aircraft industry rose by 13% between July and September, 1950, to a total of 291,100, whereas in 1944 roughly 2,000,000 were employed.

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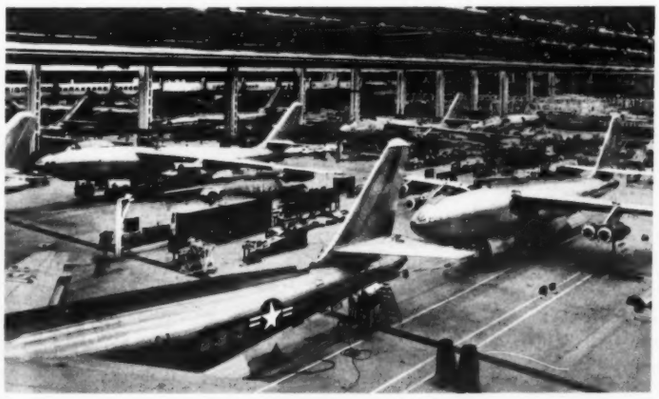
The same applies to aircraft plant. By May, 1951, North American Aviation Inc., will have an additional 238,000 square feet of production space in use. Consolidated Vultee's San Diego division is planning to reopen its wartime shadow factory (B-36 bombers and parts for the B-50 "Superfortress"). The Bell Aircraft Corp. (which made a net profit of $786,200 in the first nine months of 1950) is negotiating the purchase of the Fort Worth (Texas) plant belonging to the former Globe Aircraft Corp., which is at present used as a Government warehouse.

*

And raw materials? At the end of November the American National Production Authority ordered that with effect from January 1951 the allocations for civilian use of aluminium be reduced by 35%, copper by 30%, nickel by 65%, zinc by 80% and cobalt by 70%. As regards rubber, it seems as if an increase in the production of synthetics will be able to overcome the present bottle-neck. The Aircraft Industries Association of America and the Air Transport Association of America, supported by the CAB and the CAA are at present making efforts to obtain higher allocations for air transport requirements.

The *Boeing B-47 "Stratojet"* atom bomb carrier, with six jets, in series production at Boeing's Wichita (Kansas) plant.



Night work again. Long-range B-36 B's being fitted with four General Electric J-47 jet engines to supplement existing power plant, at the San Diego (California) plant of Consolidated Vultee Aircraft Corp.

America's Largest Blimp, the Goodyear N-1

Non-rigid airships (e.g. the Goodyear K shown here) were used in large numbers during the last war as "convoy watchdogs."

Before the last war it was the considered opinion of responsible circles that although there might be a certain future for airships as civilian means of transport, in military operations they were very much a thing of the past. But the exact opposite was found to be true! Nothing more has been heard of civil airship traffic since the destruction of the hydrogen-filled rigid LZ-129 "Hindenburg" at Lakehurst (on 6th May, 1937). The German Zeppelin company (Zeppelin-Reederei) made efforts to obtain non-inflammable helium gas from the USA for the sister ship LZ-130, but did not succeed and so had to abandon passenger services. On the other hand America, who holds a monopoly in the production of helium, used non-rigid airships, so-called "blimps," in large numbers during World War II for convoy protection and mine-detection.

On this subject *Vice-Admiral C. E. Rosendahl* has reported[1] that although in December, 1941, there were only six relatively old airships of various types and one single base (Lakehurst) available, at the end of hostilities there were Naval airships on the Atlantic and Pacific coasts of both Americas and in the Mediterranean. They made 55,900 service flights and were 550,000 hours in the air. Altogether 130 non-rigid dirigibles for patrol service (class K) and another 26 for training purposes (classes G and L) were built during the war, and in addition an unknown number of larger ships of classes M and XM, the latter setting up a new world endurance record (without refuelling) of over a week. All the U.S. Navy's non-rigid airships were made by the *Goodyear Aircraft Corporation*, a subsidiary of the Goodyear Tire and Rubber Co., and it is expected that the "biggest blimp of all time," the newest Goodyear Class N, 324 ft. long with a helium content of 875,000 cu. ft., will shortly start its test flights.

[1] Cf. C. E. Rosendahl: "Today's Airship Situation," INTERAVIA, Review of World Aviation, November 1947, pp. 23-25.

Helium, the only safe lifting gas for airships, is found in sufficient quantities only in the U.S.A.

The newest blimp (N type) being completed at Goodyear Aircraft Corp.'s huge shed at Akron (Ohio). The envelope is 324 ft. and has a helium content of 875,000 cu.ft. Weighted netting holds the helium-filled envelope in place whilst the car is fitted underneath.

The eyes of convoys and naval task forces.

The submarine continues to be a major enemy in the global strategy of the Atlantic Treaty Powers, who are so dependent on their sea communications. This point was recently made by *Captain Norman Macmillan* in Interavia Review.[2] Only a "three-dimen-

[2] Cf. Captain Norman Macmillan: "The Rôle of Sea Power in European Defence," Interavia, Review of World Aviation, Vol. 5, No. 12, p. 614.

Working with aircraft and warships in the hunter-killer team of a naval task force : a Goodyear K blimp (252 ft. long ; 425,000 cu.ft. helium) lands on its floating base, the aircraft carrier U.S.S. "Sicily."

sional" fleet can counter this threat—ships, aircraft and possibly underwater craft. What of the airship?

In areas where the enemy employs land-based aircraft as well as submarines the airship cannot afford to appear. However, the newest submarines have such long ranges, even when submerged, that they can nowadays operate in all waters.[3]

The blimps' operational field therefore lies off the coasts of America, in the West and South Atlantic, the Pacific and the Indian Ocean. Unlike aircraft they can adapt their speed to the convoy's slow rate of progress. They can fly by day or night and in any kind of weather. The latest versions can remain in the air for a very long time, and procedures for refuelling while hovering above a surface vessel are being worked out.

When a blimp spots a submarine by means of its radar instruments and sound buoys, it can either attack it itself or radio for help from destroyers, carrier-borne anti-submarine aircraft or land-based aircraft. Even the K type, now over 10 years old, carried a machine gun post and had bombs and depth charges on board. The new N type is doubtless much more powerfully armed. However, the task of the blimp seems still to be the detection of submarines. Its job is to see, not to fight!

Even during the exercise by a carrier task force in the Caribbean two years ago two airships were attached to the aircraft carrier USS "Sicily" and its aircraft squadrons and escort destroyers. They formed the reconnaissance element of the hunter-killer team composed of all available weapons for anti-submarine operations. Twice a day the two blimps landed on the flat top to change crews and take on fresh supplies of fuel, ammunition and food. The K-type, however would have been able to stay up for 50 hours (or 2500 miles), and classes M and XM considerably longer.

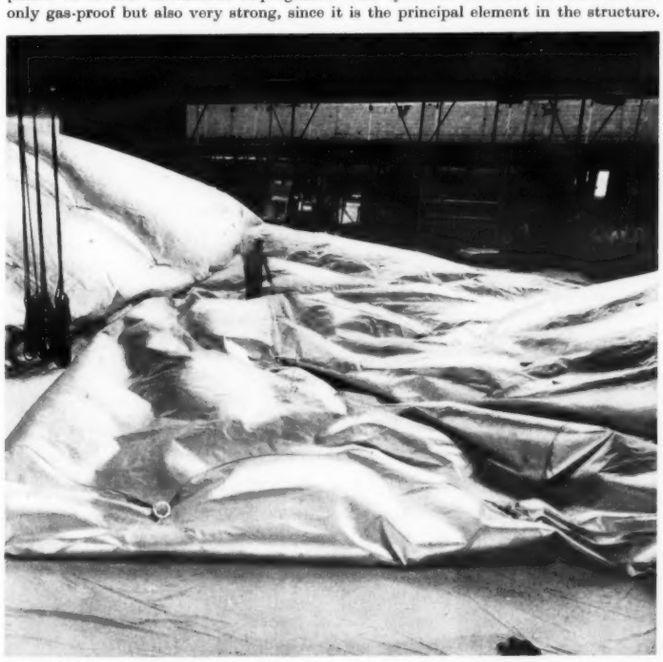
Since the outbreak of the Korean war the training of airship pilots in the U.S. Navy has been going ahead at full speed. Naval air pilots, in groups of 26 officers, undergo a three months' training as airship captains at Lakehurst. The course includes 150 hours of day and night flying per student over continent and Atlantic, ground service, as well as theoretical instruction in maintenance, meteorology and navigation.

Flying Pneumatic Tyres.

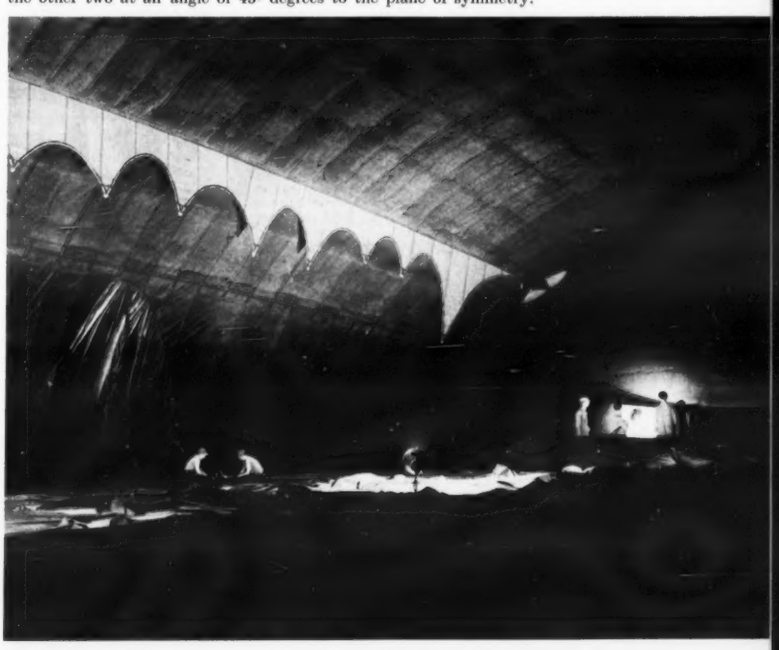
The basic design of the Goodyear N-1 is the same as that of all other American airships, the simple principle of the automobile tyre in aerodynamic form. Pneumatic tyres hold the outer envelope in shape.

[3] It is to be assumed that the experiments made by the Germans (Scheffler Research Institute, Berlin-Gatow) towards the end of the war, in travelling under water without Snorkel tubes with the aid of Diesel engines—the exhaust gases were re-charged with fuel and oxidizer and circulated so to speak in a closed circuit—have been developed further by all the Great Powers. The last German U-boats could already travel several thousand sea miles under water at a speed even higher than that of destroyers of the time. Today submarine cruisers of 10,000 ton displacement and a speed of 35 knots for underwater travel are said to be in course of development in the Soviet Union.

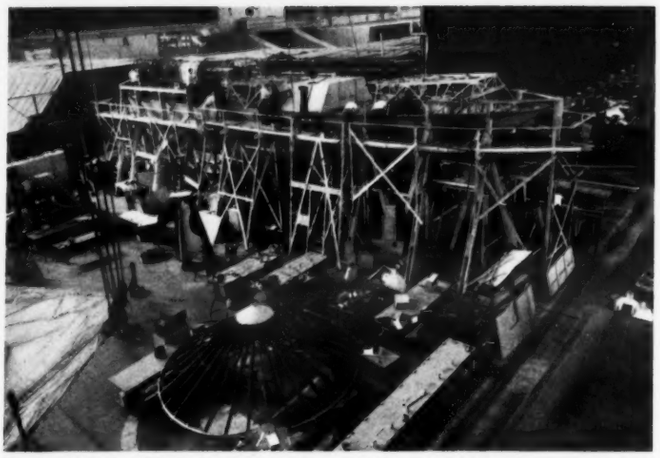
The N-1's envelope is cemented, stitched and vulcanised out of numberless fabric panels of several thicknesses impregnated with synthetic rubber. It must be not only gas-proof but also very strong, since it is the principal element in the structure.



Inside the envelope : Outside cables and compressed air blown inside make it possible to test every single fabric panel. Steel cables will be fitted on the edges of the catenary curtain for internal stiffening. Two of these curtains are at an angle of 15 degrees, the other two at an angle of 45° degrees to the plane of symmetry.



The airship nose is reinforced by light metal battens and steel cables. It also carries a mast mooring pendant (not shown here) and two remote-controlled winches for the forward mooring cables.



Constructing the 42½ ft. long light metal car of the N-1, which carries a crew of 14, their equipment and armament, two 800 h.p. radial engines (Wright R-1300 "Cyclone 7"), fuel supplies and water ballast. In the foreground are the nose stiffeners.

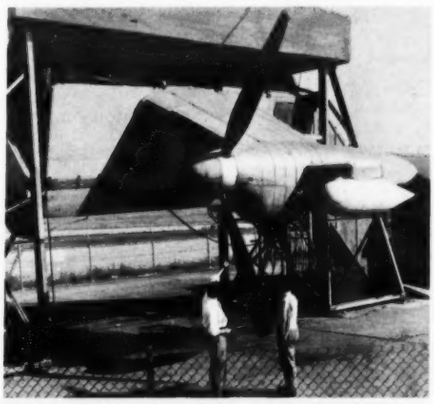
To achieve static lift a gas filling had to be put between the "outer cover," *i.e.* airship hull, and "inner tube." In addition two "tubes," *i.e.* two air ballonets are contained in the envelope, one fore and the other aft. This simplifies design and enables the trim of the ship to be adjusted. The pressure differential between the helium and the surrounding atmosphere is kept very small, to avoid higher losses of gas. It is of the order of 1½ to 2 in. of water (5/1000 atm.), which nevertheless, because of the large diameter of the envelope, suffices to keep the envelope in shape.

Since the two air ballonets (fore and aft in the envelope) have to maintain the same pressure differential in relation to the surrounding atmosphere, they must be able to change their volume. Their greatest volume, *i.e.* about one third of the total volume, in general is at sea level. At higher levels the helium expands. Therefore air is let out of the ballonets until they are almost empty. This means that none of the valuable helium (and no static lift) is lost. Only if a greater height is required after the ballonets are empty must helium be let off. Pressure and contents of the ballonets are regulated by an air circuit. The two propellers send part of the air pushed rearwards through the scoops in the outrigger cowlings (when the engines are idling there are electrically driven blowers for this purpose) and pass it via a system of tubes and valves to the fore and aft ballonets. Superfluous air passes out into the open again via discharge louvres. In addition in an emergency —when the ballonets are already full and the pressure differential continues to fall—air can be blown into the actual gas space where it mixes with the helium. By varying the amount of air in the fore and aft ballonets the ship can be trimmed longitudinally.

The envelope of an airship is needless to say subjected to particularly heavy stresses. It must withstand not only the static pressures of the lifting gas but also the dynamic stresses developed in flight. It is the primary structural element, must remain gas-proof and be able to withstand the effects of weather (rain, heat, hail, etc.). It is therefore made of very firm, several-ply fabric, proofed with synthetic rubber (Neoprene). It is made of several panels, sewn and cemented together, vulcanized and finally coated inside with paraffin. The ballonets, which are made in the same way, are also coated with paraffin to prevent the diffusion of gas. Steel cables attached on the one hand to four catenary curtains inside the envelope and on the other to the connecting tube of the ballonets in the bottom of the envelope, form the inside stiffening system. The nose is stiffened by means of a framework of light metal battens. The tail surfaces, also of light metal, are braced by cables.

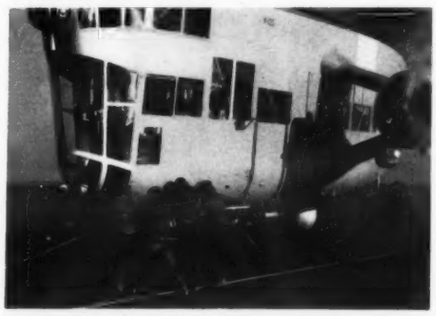
Dimension, weights and performance:

Length:	324 ft. (99 m)
Beam:	72 ft. (22 m)
Height:	91 ft. (28 m)
Helium volume:	875,000 cu.ft. (24,800 m³)
Engine power:	1600 h. p. (1620 CV)
Speed:	approx. 75 knots. (140 km/h)
Max. flying weight:	approx. 66,000 lbs. (30 t)
Weight empty:	approx. 33,000 lbs. (15 tonnes)



The reversible pitch propellers (Curtiss-Wright) 18 ft. in diameter are carried on outriggers and are driven by long transmission shafts. Their nacelles also take the main undercarriage wheels (nose wheel beneath the front of the cabin); air scoops for the fore and aft ballonets, which keep the airship inflated, are fitted in the leading edge of the outrigger cowlings.

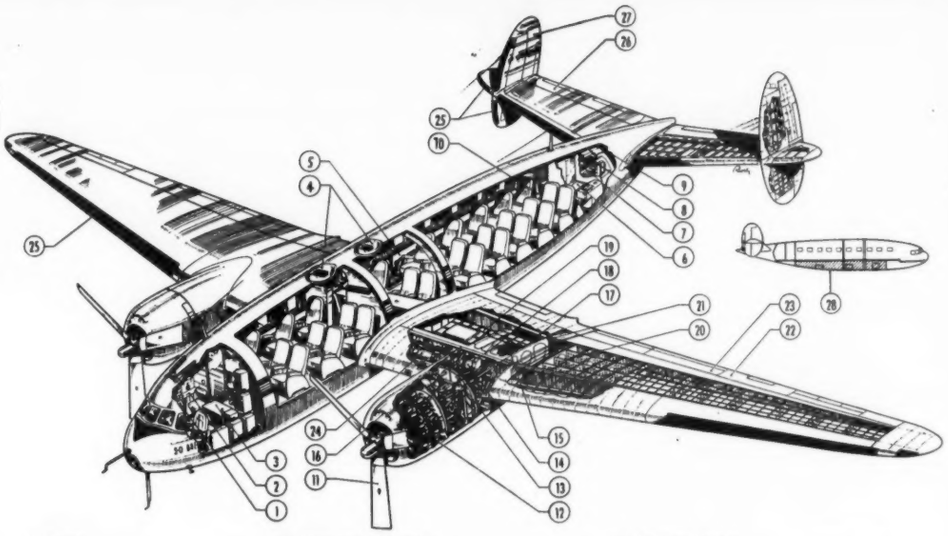
The car of the K type is much smaller, and does not carry the engines. Machine gun post in the nose; entrance from the rear.



The N-1's double deck light metal car is 42½ ft. long and contains ample space for the crew of 14 and their highly specialised navigation, radio and radar equipment. It is attached to the envelope by means of stiffened fabric curtains. For the first time in a blimp the two air-cooled engines (800 h.p. Wright "Cyclone 7") are carried in the car and are therefore accessible in flight. Either engine can drive both propellers. The fuel tanks (and special pipes for refuelling while in flight) are also inside the car, as are the containers and pipes for taking up water ballast from the sea. For "dynamic take-offs," *i.e.* ascents under power –at weights greater than correspond to the static lift—and for landings on a flat top or an airfield there is a retractable tricycle landing gear. The main wheels are at the ends of the outriggers and the nose wheel under the forward end of the cabin.

SO 30 P "BRETAGNE"

Structural details, Characteristics and Performance



1. Pilots
2. Engineer
3. Radio operator
4. Radio compass
5. Passengers' baggage rack
6. Toilets
7. Hostess's seat
8. Galley
9. Cloakroom
10. Entrance door
11. Hamilton propeller
12. P. & W. R-2800 CA.18 engine
13. Fireproof wall
14. Oil tank
15. Main undercarriage wheel (retracted)
16. Air inlet
17. Rear spar
18. Forward spar
19. Hold in centre section or compartment for flexible tank
20. Integral tanks
21. Junction of outer and centre sections
22. Aileron
23. Wing flap
24. Radiator for air conditioning
25. Wing and tail surface de-icing
26. Elevator
27. Rudder
28. Three holds in fuselage

The SO 30 P "Bretagne" is an all-metal twin-engined commercial transport designed for the carriage of passengers and freight on short and medium stages (300 to 1200 miles).

*

Fuselage: Sealed, circular section, stressed skin monocoque strengthened by a system of bulkheads and stiffeners. The fuselage is made in several sections joined together during assembly. It is reinforced locally by fairings and bulkheads to carry the weight of the nose wheel, the wings and the tail surfaces. Entrance starboard aft. Holds beneath the floor of the cabin, lined with corrugated sheet to protect the structure.

Wings: Mid-wing position, twin spar with stressed skin, formed of two half-wings each comprising an inboard box girder carrying an engine nacelle and an undercarriage leg (retracted behind the engine) with a compartment between the fuselage and the engine nacelle where an additional fuel tank or cargo can be accommodated; a trapezoidal outboard box girder with integral fuel tanks and connected to the inboard girder by joining the flanges of the spar and bolting together the end ribs, a detachable box at the leading edge containing control lines and conduits and a trailing edge box composed of movable parts.

Wing flaps (Fowler flaps): In three portions (on each half wing), one on the centre section and two on the outer section (the end of the engine nacelle moves with the portion on the centre section). The flaps slide on guide rails and are operated by toothed rods from hydraulic jacks.

Ailerons: Frise type, control by special jack.

Tail surfaces: Double fin and rudder unit, stressed skin, torsion-resistant. Controls balanced statically and aerodynamically. Spring loaded tabs on the rudder, aerodynamic balance surfaces on the elevator.

Undercarriage: Tricycle, retractable, single wheels. Hydraulic shock-absorbers, electro-hydraulic retraction mechanism; hydraulic brakes on the main wheels, nose wheel swivelling.

Equipment: Pneumatic de-icing of wings and tail surfaces: spirit and thermal de-icing of windscreen. Cabin heated and pressurised, with fully adequate ventilation even at low altitudes and in warm weather. Full radio and blind landing equipment.

Power Plant: The SO 30 P is produced in two versions:

Mark I: Two 18 cylinder two-row Pratt & Whitney R-2800 B.43 "Double Wasp" engines of 2000 h.p. at take-off, with two-speed supercharger, driving four-bladed Curtiss-Electric constant-speed quick-feathering propellers, diameter 13 ft 5½ in.

Mark II: Two 18 cylinder two-row Pratt & Whitney R-2800 CA.18 "Double Wasp" engines of 2400 h.p. at take-off with water injection, two-speed super-charger, driving three-bladed Hamilton Standard "Hydromatic" constant-speed and reversible pitch propellers with automatic feathering, diameter 13 ft 5½ in.

WEIGHTS		Mark I de luxe 30 passengers	Mark I Coach 43 passengers	Mark II de luxe 30 passengers	Mark II Coach 43 passengers
Weight empty [4]	lbs	29,910	27,770	28,220	28,080
	kg	12,660	12,595	12,800	12,735
Weight empty with operational equipment	lbs	29,590	29,490	29,990	29,890
	kg	13,420	13,370	13,605	13,560
Useful load (fuel + passengers + freight)	lbs	11,200	11,300	13,000	13,100
	kg	5,080	5,125	5,895	5,940
Take-off weight	lbs	40,790	40,790	42,990	42,990
	kg	18,500	18,500	19,500	19,500
RANGE					
at a power of		2x900 h.p.		2x1000 h.p.	
at altitude of		10,000 ft (3050 m)		10,000 ft (3050 m)	
with A.T.A. reserve (200 miles + 45 mins) and head wind 10 m.p.h.					
with 30 passengers (165 lbs) and 3520 lbs baggage and freight	miles	315	340	705	730
	km	505	545	1135	1175
with 30 passengers (165 lbs) and their baggage (33 lbs per person) [5]	miles	910	935	1260	1285
	km	1465	1505	2030	2070
with 43 passengers (165 lbs) and their baggage (33 lbs per person)	miles	—	325	—	720
	km	—	525	—	1160
maximum [6]	miles	1520	1520	1390	1390
	km	2450	2450	2240	2240

PRINCIPAL DIMENSIONS

Span	88 ft. 2 in.	26.90 m
Length	62 ft. 2 in.	18.95 m
Height	16 ft. 1 in.	4.90 m
FUSELAGE		
Maximum cross-section	9 ft. 5 in.	2.86 m
Main cabin : length	32 ft. 10 in.	10.0 m
height	6 ft. 3 in.	1.90 m
width	9 ft. 0 in.	2.75 m
volume	1,519 cu ft.	43 m³
floor area	269 sq. ft.	25 m²
Rear compartment (hostess, galley, cloakroom)	166 cu. ft.	4.7 m³
Holds under the floor	282 cu. ft.	8 m³
Holds in centre section	71 cu. ft.	2 m³
WINGS		
Total area	925 sq. ft.	86 m²
Mean chord	11 ft. 3 5/8 in.	3.445 m
Dihedral of centre section		1° 30'
of outer panels		6° 30'
High lift flaps	142 sq. ft.	13.20 m²
Ailerons	56 sq. ft.	5.20 m²
UNDERCARRIAGE		
Track	24 ft. 7 in.	7.5 m
TANKS		
Integral tanks in outer wing sections	2x345 Imp. gals.	2x1560 lit
Bladder-type tanks in centre section	2x187½ Imp. gals.	2x 850 lit.

POWER PLANT	Mark I	Mark II
Take-off power	2x2000 h.p.	2x2400 h.p.[1] 2x2100 h.p.[2]
Maximum continuous power supercharger in low gear at altitude of	2x1600 h.p. 5300 ft. (1615 m)	2x1900 h.p. 4000 ft. (1220 m)
supercharger in high gear at altitude of	2x1450 h.p. 13,200 ft. (4040 m)	2x1700 h.p. 13,500 ft. (4115 m)
Rated power supercharger in low gear at altitude of		2x1800 h.p. 6000 ft. (1830 m)
supercharger in high gear at altitude of		2x1600 h.p. 14,500 ft. (4420 m)
Maximum cruising power supercharger in low gear at altitude of	2x1100 h.p. 10,000 ft. (3050 m)	2x1200 h.p. 10,000 ft. (3050 m)
supercharger in high gear at altitude of	2x875 h.p. 20,000 ft. (6100 m)	2x1200 h.p. 16,000 ft. (4880 m)
LEVEL SPEEDS		
Maximum speed at altitude of	292 m.p.h. (470 km/h) 13,200 ft. (4040 m)	301 m.p.h. (485 km/h) 13,500 ft. (4100 m)
Cruising speed at altitude of	258 m.p.h. (415 km/h) 19,700 ft. (6000 m)	273 m.p.h (440 km/h) 16,400 ft. (5000 m)
ICAO take-off distance with full weight and failure of one engine	5365 ft / 1535 m	4825 ft / 1470 m

RATE OF CLIMB		
At sea level and at maximum take-off weight on two engines at maximum continuous cruising output	1000 ft./min / 5.1 m/sec	1380 ft./min / 7.0 m/sec
on one engine at take-off power in take-off conditions	315 ft./min / 1.6 m/sec	394 ft./min / 2.0 m/sec
TAKE-OFF AND LANDING		
Take-off run with full weight to clear 50 ft (15 m) obstacle	3290 ft. / 1025 m	3200 ft / 975 m
Landing run at full take-off weight less 1100 lbs (500 kg) after clearing 50 ft (15 m) obstacle	2970 ft. / 1025 m	3085 ft. / 940 m
SERVICE CEILING		
on two engines at maximum continuous power	26,570 ft. / 8100 m	25,590 ft. / 7800 m
with total weight of	39,680 lbs / 18,000 kg	41,890 lbd / 19,000 kg
on one engine at maximum continuous power with total weight of	10,500 ft. / 3200 m / 37,480 lbs / 17,000 kg	10,170 ft. / 3100 m / 39,680 lbs / 18,000 kg

[1] With water injection
[2] Without water injection
[3] The « Coach » version has a removable galley. Its omission and that of the food normally carried in it gives a saving of 495 lbs (225 kg) in weight.
[4] To be increased by 265 lbs (120 kg) for aircraft with removable tanks in the centre section
[5] With centre section tanks fitted

SO 30 P "BRETAGNE"

Evolution and Development

In November, 1946, the SO 30 R " Bellatrix ", prototype of a series of twin-engined, commercial aircraft [1], reached the Brétigny flight test centre where it seemed to confirm the qualities previously shown by the SO 30 N built on similar lines.

About the same time the newly-formed International Civil Aviation Organization was laying down the basic standards to be applicable in the Organization's member countries. These regulations required performances during take-off and for flight on one engine which were higher than those on which the SO 30 specifications drawn up in 1941, were based.

Moreover, the future operators—chiefly Air France—began to make known their requirements as regards passenger accommodation, equipment, installation of the control cabin, and radio equipment of the new type. They naturally wanted an aircraft which would not need any further modification on any of these points on being taken into service.

This attitude, the expression of a legitimate anxiety on the part of the future operators, added considerably to the manufacturers' difficulties because of the repeated stoppages and delays which it entailed in the production of the series. Specifications were constantly modified and consequently there could be no question of placing firm orders for equipment. Moreover, the latter too was constantly being improved. In this sphere the war had placed France in a relatively poor position and the real efforts made to catch up did not show visible results until long after the Liberation.

In spite of these difficulties, the SO 30 made progress, and a first machine, incorporating almost all the projected structural modifications and fitted with Pratt & Whitney R-2800 " Double Wasp " engines, made its first flight in December 1947. This first aircraft of the series was in reality a prototype, a guinea pig. It was used for testing the air conditioning and pressurization systems, the integral tanks, the constant-speed propellers and cowlings suited to the new engines and for determining flight characteristics and performance. However, immediately succeeding production models were also used for this purpose.

The object of the present article is to trace the evolution of the SO 30, from the first year when it was presented to the public, examining first the aerodynamic characteristics, then the modifications made to the aircraft and finally the measures adopted to solve certain special problems.

Aerodynamic characteristics.

In 1946 the ICAO regulations were still only in draft form, but they already contained strict provisions. For example, take-off weight was to be limited to that figure which would permit the aircraft to reach a height of 50 ft. at the end of the runway even if one engine failed beyond a certain point in the run (critical point). If the failure occurs before this point the aircraft must be capable of coming to a stop within the remaining length of the runway. In addition, the rate of climb on one engine had to exceed certain well-defined minimum values, particularly immediately after take-off.

In its original form the SO 30 R only satisfied these conditions if its weight was kept very low, in which case its useful load was not satisfactory. A series of modifications was made to remedy this situation. These have produced the present version of the machine.

Lift-increasing flaps :—A change in the type of high-lift flaps alone brought with it an improvement in take-off performance. The aircraft was fitted with Fowler flaps of characteristic efficiency and low drag. Later the ailerons were made to " droop " with the flaps, thus reducing drag still further and ensuring continuity all along the wing span when the flaps were in operation.

Engines :—It was also decided to change the type of engines. Preliminary investigations had shown that the structure of the SO 30 would, if suitably reinforced at certain points, permit the SNECMA 14 R engines which theoretically developed a power of 1700 cv at take-off, to be replaced by Pratt & Whitney R-2800 B. 43 " Double Wasp " engines of 2000 h.p. and that it would also carry the increase in total permissible weight resulting from the bigger engines.

A distinct advantage was that the Pratt & Whitney R-2800 B. 43—which was fitted in the Martin B-26 " Marauder "—was immediately available in quantity in France for installation, whereas at this time the SNECMA 14 R was still in the prototype stage.

The last 30 aircraft of the SO 30 production series were fitted with Pratt & Whitney R-2800 CA. 18 engines, developing 2400 h.p. on take-off with water injection.

Wing Centre Section :—The first makeshift propellers fitted to the B. 43 engines had Curtiss Electric hubs (" Marauder " type) and Ratier blades. They were 3.70 m (12 ft. 4 in.) in diameter. The SO 30 P No. 1 was fitted with these propellers and made its first general inspection tests with them.

However, by choosing a propeller diameter more suited to the B. 43 engines a valuable gain in take-off and climbing performance was obtained, though this meant an increase in the spacing of the engines, i.e. an enlargement of the centre section. This modification was carried out in two months and increased the wing area to 86 m² (908 sq. ft.), thus reducing the original wing loading and taking care of the extra load required for the new take-off weight.

Propellers :—A large number of comparative tests were carried out at the request of the Technical Service with different propellers of the selected diameter (4.10 m = 13 ft. 5 in.). Excellent results were obtained with Ratier and de Havilland propellers. However, the propellers at present used on the SO 30 P B.43 are Curtiss " Marauders ", which are available in France and are less expensive. The difference between their performance and that of the Ratiers was not sufficiently great to justify quantity production of the latter.

Engine cowlings :—At the same time several different types of cowling were tried, from the original " Marauder " cowling, now fitted to the first versions of the SO 30 P B.43 to the final SNCASO cowling which provides superior cooling of the engines and has better streamlining with better designed air intakes. This cowling has now been generally adopted for production (B. 43 and CA. 18 engines).

Tail surfaces :—The horizontal tail surfaces have been enlarged to counteract the disturbing effect of the propeller slipstream from the more powerful engines. The vertical tail unit has been replaced by a double fin and rudder unit. To satisfy ICAO requirements for flight on one engine this unit must have a large area, as otherwise deflection of the control surfaces would be too great and consequently drag too high. The adoption of a double fin and rudder unit of the type already used by the SNCASO (SO 161 " Languedoc " and SO 30 N) avoided the necessity for prolonged and complicated experiments with an enlarged single vertical tail unit.

As ICAO standards impose limits on the efforts demanded of the pilot, special care has been devoted to balancing the controls. The rudder controls have a spring tab (itself compensated aerodynamically in the SO 30 P CA. 18), which reduces the stick force required and thus helps to reduce the minimum control speed on one engine. The elevator controls in the production version no longer have compensation by automatic tabs, but have aerodynamic balance surfaces, which ensure excellent manœuvrability during landing and changes of attitude. They rapidly absorb longitudinal oscillations, which makes the aircraft a pleasant one to pilot.

*

On completion of this evolution the SO 30, now designated the SO 30 P " Bretagne ", appears in two versions with the following characteristics :

Mark I : Pratt & Whitney R-2800 B.43 " Double Wasp " engines of 2000 h.p. for take-off, certificated for a take-off weight of 18,500 kg (40,700 lbs).

Mark II : Pratt & Whitney R-2800 CA. 18 " Double Wasp " engines of 2400 h.p. at take-off with water injection, optionally fitted with reversible pitch propellers with automatic feathering ; permissible take-off weight 19,500 kg (42,900 lbs).

[1] Cf. " INTERAVIA, Review of World Aviation ", Vol. I, No. 5, August, 1946, pp. 20-25.

The first model of the SO 30 P CA. 18 came out at the end of 1949 and is at the moment finishing its official acceptance tests. Its increased weight and cruising speed make it more profitable in operation than the SO 30 P B. 43. The adoption of CA.18 engines was postponed for a long time, principally because of dollar difficulties. It was finally decided upon for the greater part of the series, Air France's views in this connection undoubtedly being one of the deciding factors.

Equipment

The accessories and equipment for the SO 30 R had been decided upon long before the Liberation with the different agencies interested (Air Ministry, Air France, etc.). However, the equipment for the fuselage had been chosen in the light of experience gained before the war and for the operating conditions of that time. These conditions were changed once peace was restored, and air services were reorganised.

Radio : The radio equipment was inevitably found to be inadequate. Moreover, it did not include the modern equipment perfected in the U.S.A. during the war to provide greater safety in flight. The composition of the radio-electric equipment was repeatedly modified up to 1950. It is interesting to compare the equipment mounted in the SO 30 R with that now fitted in Mark II of the SO 30 P :—

SO 30 R : Navigation : a blind landing set (L.M.T.), two D/F sets (AG.222) ; traffic : one principal transmitter-receiver (S.A.R.A.M. 312), one emergency set (S.A.R.A.M. 035).

SO 30 P : Navigation : one blind landing set (S.C.S. 51 Bendix with cross pointer instrument and marker beacon signal lights), a radio altimeter (S.F.R. Aviasol), a radio compass (Bendix SCR 269 G) for the pilot, a D/F set for the radio operator (Bezu MB. 12); Traffic : two transmitter-receivers (one V.H.F. AN.ARC/1 modified and one ART 13 Collins), a Jaeger set for long-distance communications (short and medium waves, comprising a TA 2X transmitter and two RA.1U receivers, one of them for normal and one for emergency use) ; intercommunication system.

To accommodate the new equipment without reducing the number of passengers, the front of the fuselage was lengthened so as to provide a space between the front wall of the cabin and the pilots' cockpit. The radio operator sits facing the direction of flight.

Control compartment : It was found advisable to modify the transparent nose of the SO 30, which had been composed of a series of curved panels following the shape of the fuselage, a good arrangement from the aerodynamic point of view, which is employed in several foreign prototypes, notably the de Havilland " Comet ".

However, because of production difficulties in France at the time, the two curved panels in front of the pilot did not have sufficiently good optical qualities, so that they were replaced by flat Triplex panels, which slightly modified the silhouette of the aircraft (fig. 1 and 4).

All the usual measures have been taken to ensure visibility in rain or under icing conditions (some of the equipment is duplicated for safety) : windscreen wiper, anti-icing by heating the front panels, spraying with alcohol of the outside windscreen surfaces, hot-air scavenging of the inside, bad-weather windows which can be opened by the first pilot.

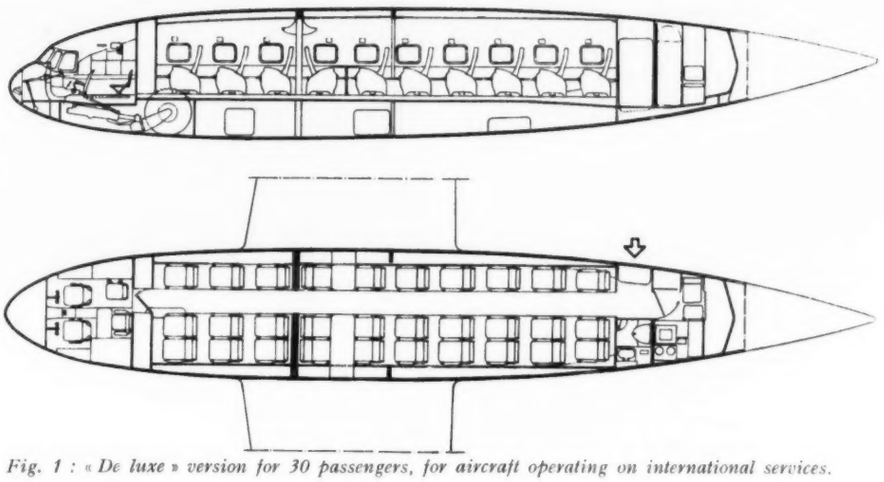


Fig. 1 : « De luxe » version for 30 passengers, for aircraft operating on international services.

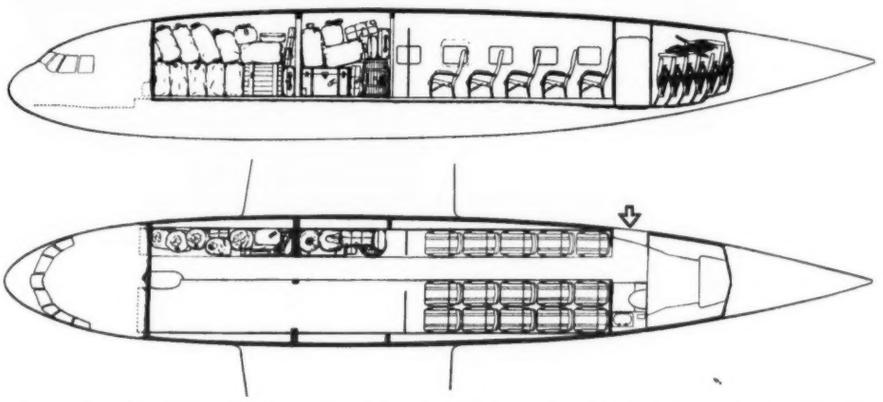


Fig. 2 : Mixed passenger-mail version. The wall separating the cabin from the freight compartment is movable, and the operator can instal as many chairs as required for each particular flight. The chairs not in use are folded and stowed in the rear hold.

Cabin equipment : In 1947, Air France, wishing to give their passengers the maximum comfort, requested the installation of a cloakroom and the conversion of the bar into a galley.

For this purpose, the airtight bulkhead forming the rear of the cabin had to be moved further back. The small rear compartment (not accessible in flight) was replaced by a cloakroom, the toilets were moved further forward and to the left, just at the rear end of the cabin aisle. The new galley and the hostess's post are thus next to the cloakroom, on the opposite side to the entrance door, towards the rear.

The galley contains everything necessary for keeping food and drink in good condition (shelves, refrigerator, thermos containers). It has an electric stove and a sink (with water tank). The hostess has a telephone to enable her to communicate with the crew and a series of light indicators to show when passengers require her services.

The cabin itself has been slightly altered. The bulkhead separating the central from the rear bay has been removed, and baggage nets have been fitted.

Several different seating arrangements are possible. For example, the " de luxe " arrangement is designed for Air France's main international services (fig. 2 and 5) ; in addition to 30 passengers it carries a large quantity of baggage and freight. The passengers are accommodated in very comfortable adjustable armchairs, with plenty of leg room (with ash-tray, pockets, and push-buttons for service). Small individual tables can be attached to the chair-arms. There are easily accessible racks for hand baggage. Strip lighting in the ceiling and individual reading lamps provide good lighting. Air conditioning ensures full comfort for the passengers.

Another cabin arrangement has been designed for companies who carry a varying proportion of freight and passengers (fig. 3). It has 43 seats (rapidly removable) so that seasonal fluctuations in demand can be met. At certain times of the year or, in the case of certain lines, in one direction only, passenger traffic is dense. When this traffic diminishes the operator removes some of the seats and carries freight in the cabin. He can thus adjust the number and spacing of seats to suit the operating conditions of the moment. He can even provide the " de luxe " arrangement by fitting 30 super-comfort armchairs. The second type of accommodation, known as the " coach " arrangement, is being produced at the moment for *Air Algérie*. The cabin is also pressurized and air conditioned and the only changes have been minor ones in decoration. The galley can be omitted and a hold or four additional chairs fitted instead.

Finally, the greatest versatility in operation has been provided in the SO 30 C cargo version, derived direct from the SO 30 P. Its fuselage has been modified to enable large loading doors to be fitted in the rear, but no change has been made in the general design. The SO 30 C is equipped to carry heavy freight or vehicles. In military use it could be used for the most varied missions (transport, parachuting of troops, jeeps, etc.).

General : In addition to the major modifications many others were made at less conspicuous points, such as locking of the controls from the pilots' cockpit, light indicators to show when the doors are shut, improvement in the safety precautions, in particular against fire, installation of an emergency set of electrical and hydraulic instruments, emergency oxygen supply in the crew compartment, rearrangement of the instrument panel, etc.

Development of individual parts

The SO 30 P is the first French aircraft —and the only one at present in operation— to have a tricycle undercarriage, integral fuel tanks and a pressure cabin. Particular care was therefore devoted to these three details.

Integral tanks : These are located in the outer wing sections. The tight riveting and the " Fairprène " rubber packings between the joints of the metal sheeting and the ribs ensure absolute tightness. In time, however, even though the wings are built with the greatest care, slight leakage may occur. It was therefore essential to find a sealing material which could be spread in thin layers, have good adhesive properties, be insoluble in petrol or its ingredients, and be resistant to heat and cold (from +100 to — 90° C). After a number of experiments the choice fell on *Divolic* and *Divopat*, which were used in conjunction to seal the joints between the metal plates.

For checking purposes the tanks are filled to a pressure of 0.15 atm. and the pressure drop due to leakage measured. This fall must be very slight before application of the Divopat and zero after application. Allowance must of course be made for the temperature when measuring the fall in pressure.

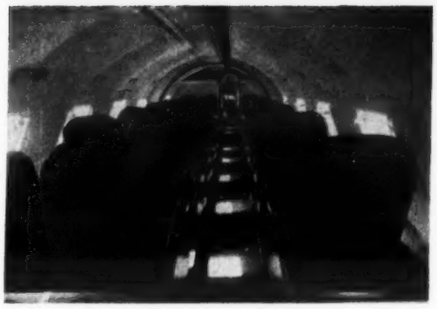


Fig. 3 : The interior of the cabin in the « de luxe » version.

Fig. 4 : The instrument panel and crew compartment (seats removed).

Undercarriage : The undercarriage of the SO 30 P was designed and built by the firm of D.O.P., who also provided the majority of the aircraft's hydraulic equipment (wheel retraction, brakes, flaps, etc.), and it was this equipment that required the greatest amount of adjustment following the modification of the aircraft. The principle of the undercarriage itself was not changed, since tests had proved it to be efficient. The main legs (retracted forwards and upwards) carry a single wheel on a cantilever axle and a single shock-absorber, the horizontal axis of articulation is based on the rear longeron of the wing, the forward jointed strut is actuated by the raising jack (fig. 6) ; the nose wheel unit (retracted rearwards) has a wheel mounted in a pivoting fork, an antishimmy device and a device for blocking the wheel in the fore-and-aft position, a jointed rear strut actuated by a side jack attached to the nose wheel leg.

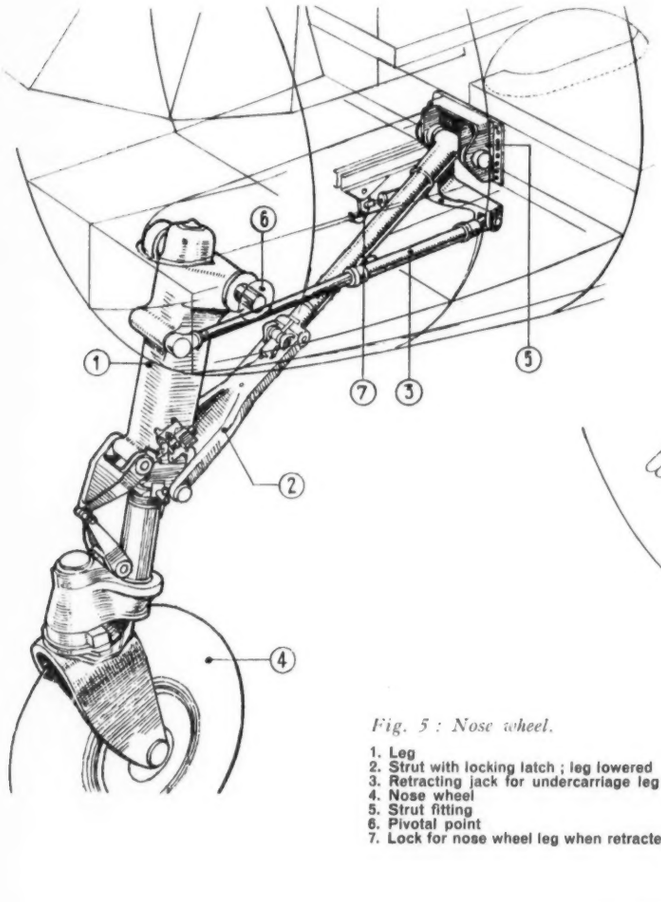


Fig. 5 : Nose wheel.

1. Leg
2. Strut with locking latch ; leg lowered
3. Retracting jack for undercarriage leg
4. Nose wheel
5. Strut fitting
6. Pivotal point
7. Lock for nose wheel leg when retracted

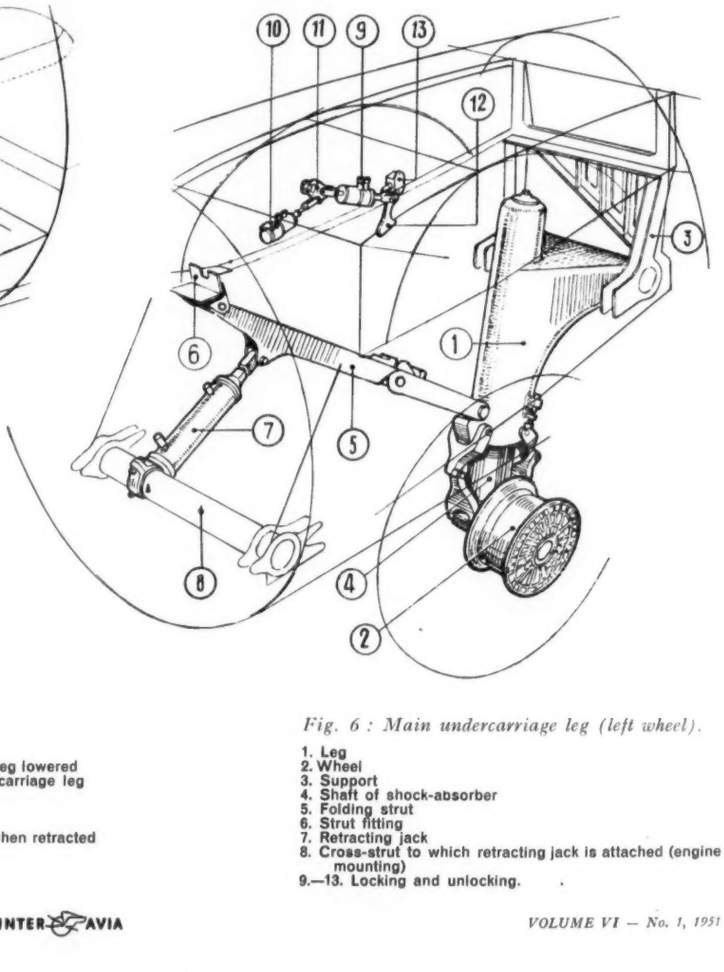


Fig. 6 : Main undercarriage leg (left wheel).

1. Leg
2. Wheel
3. Support
4. Shaft of shock-absorber
5. Folding strut
6. Strut fitting
7. Retracting jack
8. Cross-strut to which retracting jack is attached (engine mounting)
9.—13. Locking and unlocking.

The main parts of the structure are of W. 41 light alloy, which has outstanding mechanical properties. However, to reduce weight, D.O.P. are now making the main boxes of welded steel sheet, an arrangement from which the second batch of aircraft will benefit.

The main wheels are type M.A.P. No. 24 with high pressure tyres. They have hydraulic brakes. The nose wheel is a M.A.P. No. 14, with no brakes. It has a balancing mass which entirely eliminates shimmy. All tyres are made by Dunlop.

The increase in the weight of the wheels and the necessity of reducing the retraction time required a modification in the hydraulic system, inasmuch as the operating pressure was increased from 150 to 170 atm. The separate feed system for each leg was replaced by a central system comprising two Messier P 7 pumps (total delivery 14 lit/min) which meant a considerable saving in weight.

The pressure oil cylinders for retracting and lowering the undercarriage continue to be electrically controlled. Introduction of internationally standardized hydraulic fluids made it necessary to adapt the entire installation to the new fluid, notably rubber parts, return springs, etc.

The brake circuits are connected with the central feed system by means of an accumulator. They include a completely independent emergency circuit running from an accumulator charged by a hand pump. A parking brake acts on both main wheels.

Finally, the safety devices have been perfected—independent emergency circuits with hand pumps, emergency undercarriage actuator for the event of electrical failure, hydraulic emergency unlocking for lowering undercarriage, locking of undercarriage in down position on the ground, control devices on the control panel. It is these apparently insignificant details which very often constitute a considerable headache.

SO 30 P "BRETAGNE"

Flight testing

The flight testing of the SO 30 P—a total of 1100 test flights has been carried out lasting altogether 1500 hours—has brought to light a number of ways in which improvements could be made in the design and equipment of this aircraft type. Needless to say, the methods and equipment had to be carefully chosen so as to ensure satisfactory checking of the high standards required of the aircraft within the timetable laid down.

As far as methods were concerned, the SNCA du Sud-Ouest kept to a programme worked out by the flight test group of the French Secretariat of State for Air. A particular advantage was that several aircraft of the same type could be test flown at the same time.

As regards equipment, no effort was spared to fit every aircraft undergoing flight tests with the most complete and up-to-date set of measuring instruments. These were all of French make and included not only the normal indicators for direct reading by the crew (e.g. for engines, de-icing, cabin pressurisation, etc.) but also multiple recording instruments of the Hussenot-Beaudouin type to provide data for the subsequent evaluation of the tests. These latter instruments recorded all important technical details, such as :— time, altitude, temperature, speed, acceleration, angles of incidence and crabbing, angular velocity, r.p.m. and boost pressure, position of undercarriage, flaps and radiator vanes.

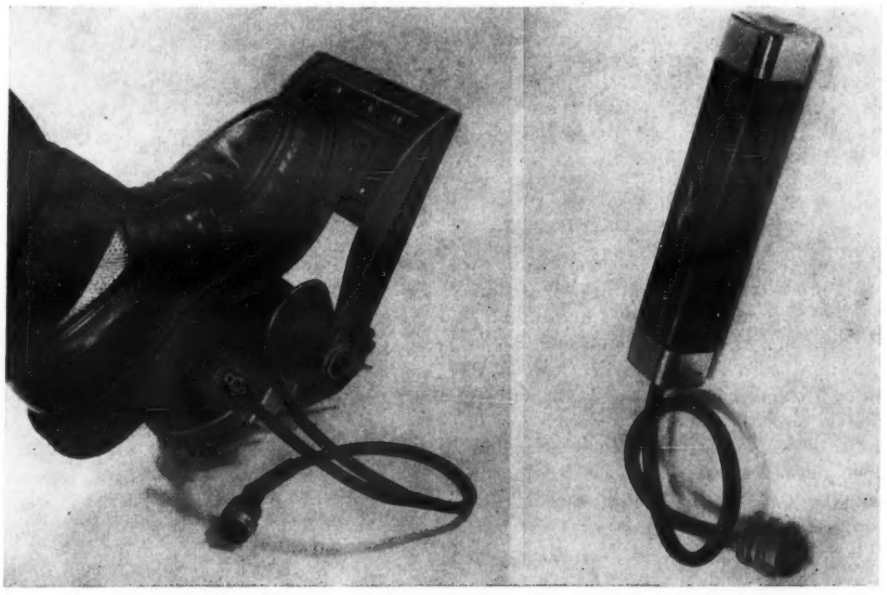
Finally additional special test instruments developed by the SNCASO were also fitted, for example the dynamometers shown in figs. 1 and 2, to measure the hand and foot forces required for the controls, and a number of manographs. The dynamometers were developed in collaboration with the Société Delord. They are composed of an electrical strain gauge and a differential galvanometer, with the aid of which the actual hand and foot forces arising are visually recorded without further amplification.*

Thanks to these installations it was possible to carry out the complicated flight manoeuvres required for the Certificate of Airworthiness (e.g. accelerating and climbing after a balked landing—fig. 3—failure of the critical engine when its propeller is windmilling—fig. 4—or feathered—fig. 5—) and a series of brake tests after breaking off the take-off run (fig. 6) without complicating the task of the pilot.

Fig. 3 shows primarily the very marked variations in elevator stick (wheel) force (marked Peson—dynamometer—in the diagram) during acceleration after an unsuccessful landing attempt. In these tests the throttles were reopened and the wing flaps completely retracted. In addition to the course of the stick forces, the diagram

* According to the makers the sensitivity of this instrument is roughly four times as great as that which can be obtained with a strain gauge in conjunction with a Wheatstone bridge. Readings are very stable and are not affected by variations in the voltage.

Fig. 1 : SNCASO's electrical stick force dynamometer is attached to the control column of the aircraft and provides a continuous recording of the control forces. The similarly arranged electrical foot force dynamometer gives a continuous recording of the rudder forces or brake pressures.



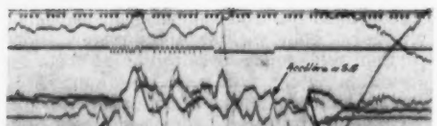


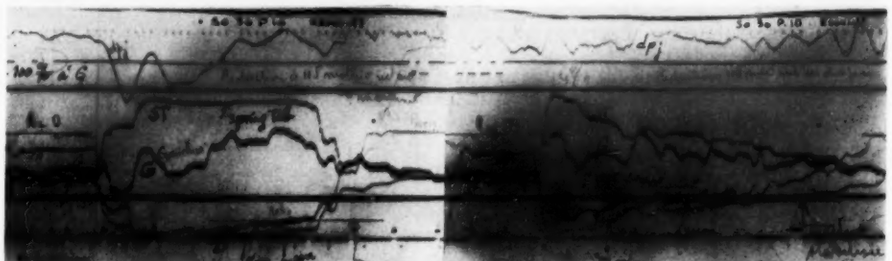
Fig. 2 : Recording of the parameters determining the flying attitude when going round again after a balked landing together with graphs of stick forces and elevator deflections.

also shows the changes in deflection of the elevator (déplacement profondeur), speed (vitesse), acceleration and angle of incidence (incidence).

Fig. 3 and 4 show the deflections of the spring-loaded compensating tabs on both rudders (ST), the deflections of the rudders themselves (D) and of the ailerons (G), as soon as one engine is throttled right down in symmetrical flight. The increase in pilot effort (foot force), its adjustment to a stationary condition and subsequent reduction on return to symmetrical flight, can also be seen. When the propeller of the dead engine is windmilling (left-hand picture) the control surface deflections and control forces are considerably greater than when it is feathered (right-hand picture). These tests served to check, both for propellers windmilling and feathered, the minimum control speed on one engine.

Finally, Fig. 5 gives a very clear picture of the almost linear increase and decrease in speed (V) during a take-off run broken off at the critical point with subsequent braking, such as was undertaken to determine the length of take-off runway required for a given take-off load (accelerate stop distance). The brake forces left and right can be seen from curves *1* and *2*. During this test the nose wheel tyre burst during the last third of the deceleration run, which obliged the pilot to reduce the brake pressure slightly, but otherwise had no effect.

The diagrams reproduced here illustrate only a few random examples from the very comprehensive test programme, in the course of which not only the flying performance of the type was determined and the flying qualities checked and improved but all other data of importance in commercial operation, such as permissible positions of the centre of gravity, maximum take-off weight, minimum and maximum flight speeds, etc., in different conditions, were also fixed.



Figs 3 and 4 : Behaviour on failure of the critical engine in symmetrical flight, on the one hand with propeller windmilling (left), and on the other with propeller feathered (right).

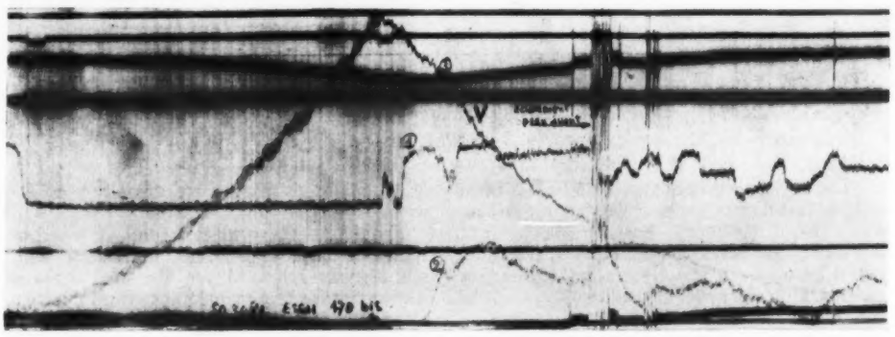


Fig. 5 : Recording of an acceleration-delay run to determine the length of the take-off runway required. When take-off speed is reached the brakes are applied full, the brake pressures (1 and 2) and the speed (V) being graphically represented.

SO 30 P "BRETAGNE"

The pressure cabin

by Paul SEVIN, Paris.

Passenger comfort has become one of the chief preoccupations of air transport companies. Such comfort is not a luxury, but is essential if fatigue is to be avoided. Speed, the trump card of air transport, loses all its value if the passenger arrives at his destination in such a state that he needs several hours of rest to recover. Hence the importance nowadays attached to the factors contributing to passenger comfort, such as cabin equipment and air conditioning.

"Conditioning" covers everything connected with the air breathed by the passengers and the crew, viz :—replacement, pressure, temperature, humidity, smells, and the question of noise.

All these points react the one upon the other and cannot therefore be dealt with separately. For example, if the air is plentifully renewed smells will automatically be carried away and the fresh air can also serve to carry the heat necessary to warm the cabin without the necessity for an air recirculation system. It is therefore tempting to provide a large volume of fresh air, but this must not be exaggerated ; compressing the air consumes a considerable amount of energy and the atmosphere at high altitudes is generally very dry, so that difficult problems of humidification are encountered.

The problem as a whole is to provide the correct degree of comfort with the minimum weight and power consumption, the maximum simplicity of operation and maintenance and complete reliability.

Pressurisation

The SO 30 P « Bretagne » has been designed for flight at altitudes where the air is not

sufficiently dense to supply an adequate quantity of oxygen to the passengers and crew for any length of time. It must therefore be compressed.

To keep the air in the cabin fresh and at the correct pressure, the compressors deliver as much as 35 lbs/min at 20,000 ft. and 70 lbs/min at ground level. This avoids the necessity for using a closed circuit system for auxiliary ventilation. After passing through the cabin the air enters the freight holds and escapes into the open through the pressure regulator.

A high volume « dynamic » ventilation system is provided for low altitudes during the summer. In this case the air is let straight into the cabin without passing through the compressors, to avoid heating it.

Normal pressure in the cabin can be regulated between 29.9 in. Hg (760 mm ; ground pressure) and 22 in. (560 mm) — equivalent to 8,000 ft. — when the aircraft flies at a height of 19,700 ft. (6000 m) where the ambient pressure is 13.9 in. (354 mm) Hg.

Compressing the air : The cabin-air compressors are of special design. They have to supply air practically free of oil (otherwise the filters in the circuit would rapidly become saturated) and be of sufficiently robust construction (a 1000-hour test run at full load without failure is required). The equipment developed by the now defunct SNCA du Centre passed all the certification tests with flying colours and the NC 73 compressor (later taken over by Bronzavia) has never given the slightest trouble in the aircraft.

Sealing of the cabin : Special arrangements had to be made to ensure that the cabin maintains the correct pressure and resists the stresses involved. Building an airtight cabin of riveted sheet with an entrance door, three hold doors, four emergency exits and a good many other possible leaks, at first seemed an almost impossible task, and the efforts of the SNCASO engineers who had to tackle this problem were regarded with a good deal of scepticism.

As a point of interest it may be mentioned that the SO 30 cabin has 110,000 rivets, 1400 ft. (430 m) of joins in the walls, 70 ft. (21 m) of mobile joints (doors, etc.), 12 sliding or turning joints (flight controls, radio apparatus, etc.). Today, the normal degree of airtightness is as follows :—after some " aging " provided by the first few hours of flight, the cabin must be able to keep up the maximum differential pressure even with one compressor out of action.

When new the cabin must be three times as airtight, i.e. the total leakage must not exceed that which would occur from piercing a hole 5/8 in. in diameter in the wall.

The principles of the proposed structure and its details were tried out in an airtight chamber, as early as 1942. At the same time efficient checking methods were developed.

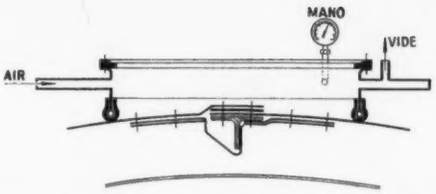


Fig. 1 : SNCASO " suction box " for checking the airtightness of the fuselage joints.

Throughout the production process of the fuselage each line of rivets is immediately checked for airtightness. The seam is first coated with a soapy solution, then an airtight box with a transparent cover is put over it and a vacuum created inside the box (figs 1 and 2). Bubbles appear round rivets that are not sufficiently tight. These can then be tightened before they harden.

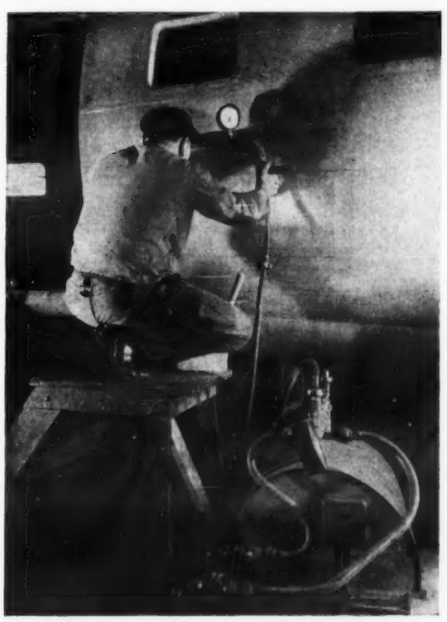
Once the cabin is finished, it is subjected to internal air pressures varying between 1.4 and 2.8 lbs/sq.in. (0.1 to 0.2 atm). Leaks are located by means of soap solution and stopped up from the inside to enable the sealing coat to penetrate better.

When the aircraft is fully assembled it is filled with air to a pressure of 5 lbs/sq.in. or 0.35 atm (in flight pressure cannot exceed 4.3 lbs/sq.in.). One aircraft successfully underwent a test at the limit of elasticity of its skin, with a pressure of 5.7 lbs/sq.in. (0.40 atm), and was found after return to zero to have suffered no permanent deformation.

Finally, leakage is also checked for each aircraft before delivery, so that the degree of airtightness required can be guaranteed.

Regulation of the pressure : Pressure in the cabin is maintained at the required value by a regulator which increases or decreases the exit of air.

Fig. 2 : Checking a line of rivets with a " suction box ".



Here, the equipment had to be designed from scratch. Up to 1945 no manufacturer of accessories had been found willing to produce a regulator answering to requirements. The specifications are strict. Pressure must be maintained with the greatest accuracy (the maximum variation permissible is 0.0007 lbs/sq.in. (5/100,000 atm) per second when the difference between internal and external pressure is 4.0 lbs/sq.in. (0.28 atm). The regulator must operate over a very wide range ; in climbing from the ground to a height of 20,000 ft. and if one compressor fails the volume of air delivered decreases from 4 to 1 while, on the other hand, the difference in pressure increases from about 1 to 10, so that the exit-section of the regulator has to be varied in a ratio of 12 to 1.

The regulator must ensure :—

— progressive reduction in pressure according to a law fixed in advance, as long as the aircraft is climbing ;

— maintenance of the existing internal pressure when the pilot ceases to climb ;

— resumption of the development of the pressure as soon as the aircraft resumes its climb ;

— constant automatic maintenance of the final cabin pressure set before departure, for cruising at the predetermined height ;

— automatic switch-over to " constant pressure differential " (i.e. maximum permissible difference between internal and external pressure) if the pilot climbs higher than originally intended ;

— simulated descent (increase in cabin pressure) according to a law similar to that for climbing ;

— switch to manual control if the automatic control breaks down.

The regulator designed by the SNCASO gives complete satisfaction. Another regulator of an entirely different design made since the Liberation by SEMCA is also to be fitted in a certain number of SO 30 P's.

Testing and final adjustments : Partial tests have been made on the compressors (by SNCAC) and the regulators (by their makers). Tests in complete aircraft have included tests on the ground, with engines running, a special arrangement enabling the pressure to be increased inside the cabin beyond the sea level value (" negative altitudes "), tests in flight (fig. 3) and tests in use on Air France and Aéro-Cargo services.

Temperature

The heating system has been designed to maintain a temperature of 68° F (20° C)

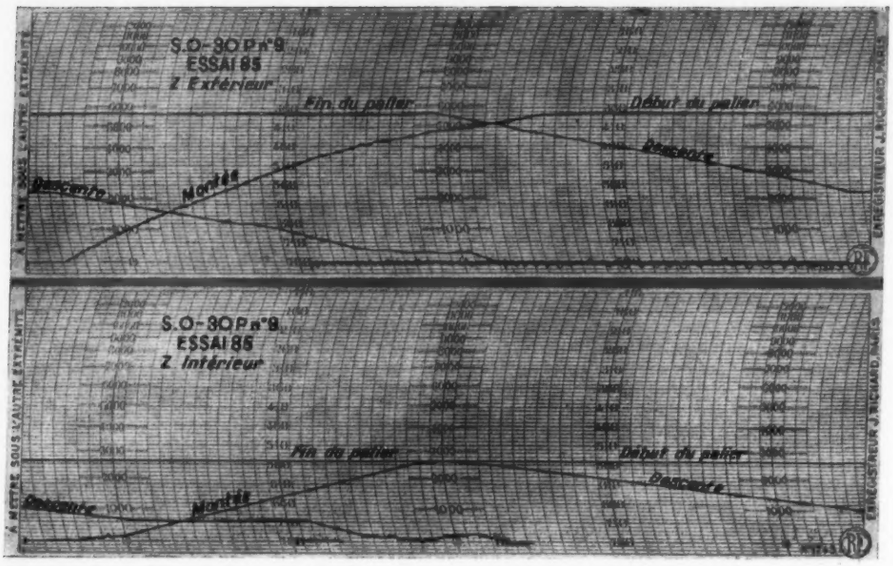


Fig. 3 : Regulating the pressure. Diagram recorded during a test flight (the top curve indicates the external pressure, i.e. that of the true altitude of the aircraft ; the bottom curve represents the variations in pressure inside the airtight cabin).

for any external temperature down to —49° F (—45° C).

High volume " dynamic " ventilation is provided for low altitudes during the summer.

Strength and endurance specifications are just as severe in the matter of heating as in that of pressurization. The Airindex petrol heaters used are designed for an output greatly in excess of that normally required so that they are capable of heating up a cold cabin in a short time. The system also has an automatic safety device which immediately cuts off the heater if a fault occurs.

Cabin insulation : Two methods have been used. In the first batch of aircraft a fibrous coating (flockage) was used, but a second batch was treated by the SEMIAT - ITA method, namely sheets of vinylite alternating with glass fibre.

The use of these new materials saved weight but necessitated a re-study of the problems of sound-proofing. To reduce noise in an aircraft has been found to be more difficult than to insulate it against changes in temperature. The sound-proofing of the first batch of aircraft has already been tested and has satisfied all requirements (which are quite strict). The second batch has not yet made its flight tests, but the tests carried out on the ground give reason to hope for no less satisfactory results.

Thermal insulation is measured in terms of the heat lost (number of B.T.U. lost per hour per square foot of radiating surface and per degree difference in temperature between interior and exterior). In the SO 30 P this figure is only approx. 0.35 B.T.U./sq. ft. h. °F (1.7 K cal/sq. m., °C, h), so that the air from the compressors can be used to provide all the heat necessary without re-circulating the used air.

Regulation : The problem of regulating the temperature is also a fairly complicated one. Difficulties arise from the following :—

— because of the wide range of temperature met with at different heights and at different latitudes oversize heating systems are generally used, which are difficult to regulate smoothly ;

— the low thermal inertia of the cabin ;

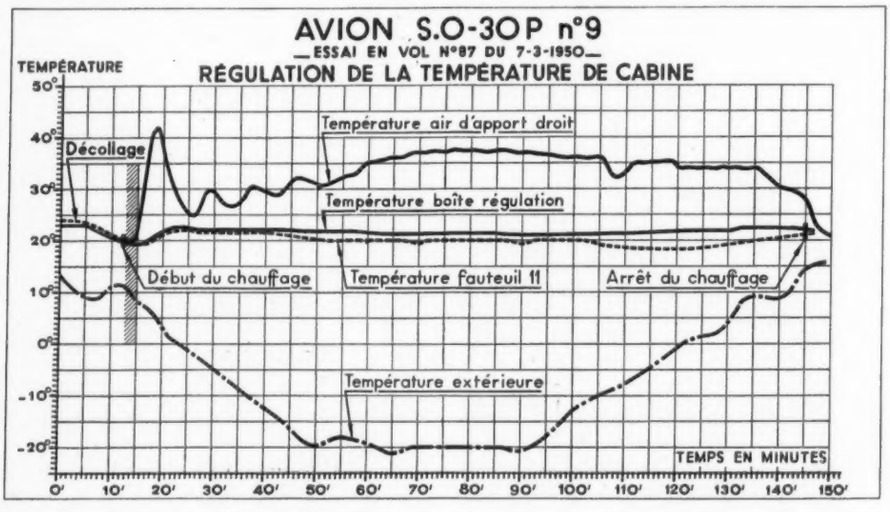
— the difference between the " time of response " of the cabin to internal influences (air introduced) and external (surrounding air). The effect of the temperature of the air introduced is immediate whereas that of the surrounding air is not felt for several minutes.

The first systems tried out were designed to make the temperature of the cabin completely independent of the outside temperature. However, they were not sufficiently reliable and were therefore greatly simplified by the introduction of a system of regulation by impulses which merely reduces the effect of the external variations but does not entirely eliminate it (a fall of 54° F (30° C) in the outside temperature entails a fall of 3° F (2° C) inside ; however a corrector knob is provided to adjust this loss).

The cabin thermostat, designed jointly by Airindex and SNCASO, directly controls the heaters. Thanks to special accessories, it has been possible to make the heating system extremely adaptable.

The graph in fig. 4 shows measurements made during a flight of two hours and a quarter. Like the numerous flights on commercial operations made during 1950, it demonstrates the efficiency of the system. Even in winter and at high altitudes passengers have praised the comfort of the SO 30 P " Bretagne's " cabin.

Fig. 4 : Regulating the temperature. Diagram showing measurements made during a test flight. Note the relative constancy of the temperature inside the cabin (temperature at regulator and near seat No. 11) and the variations in the temperature of the outside air and of the heated air.



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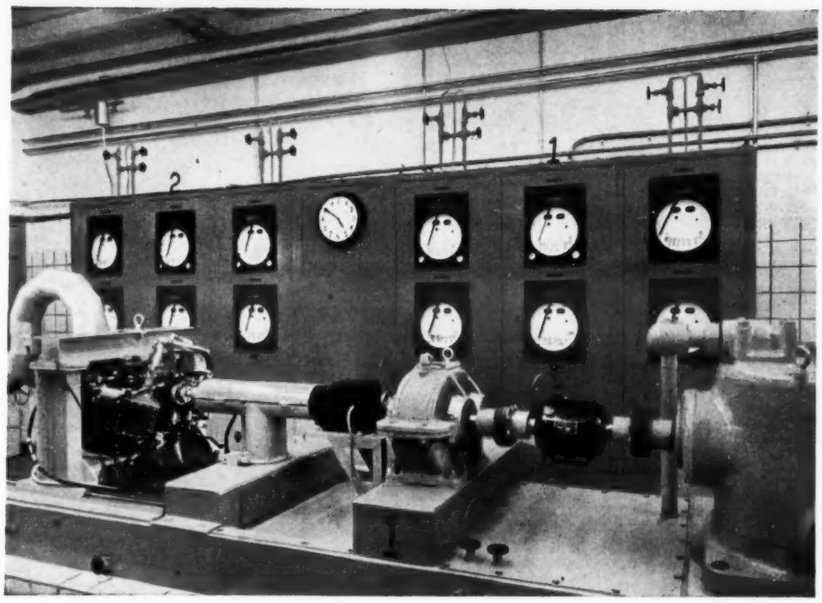

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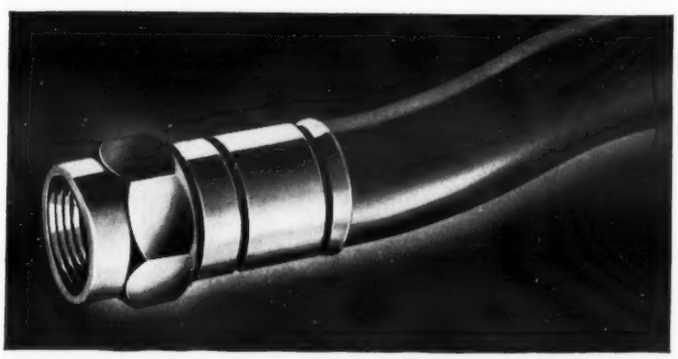

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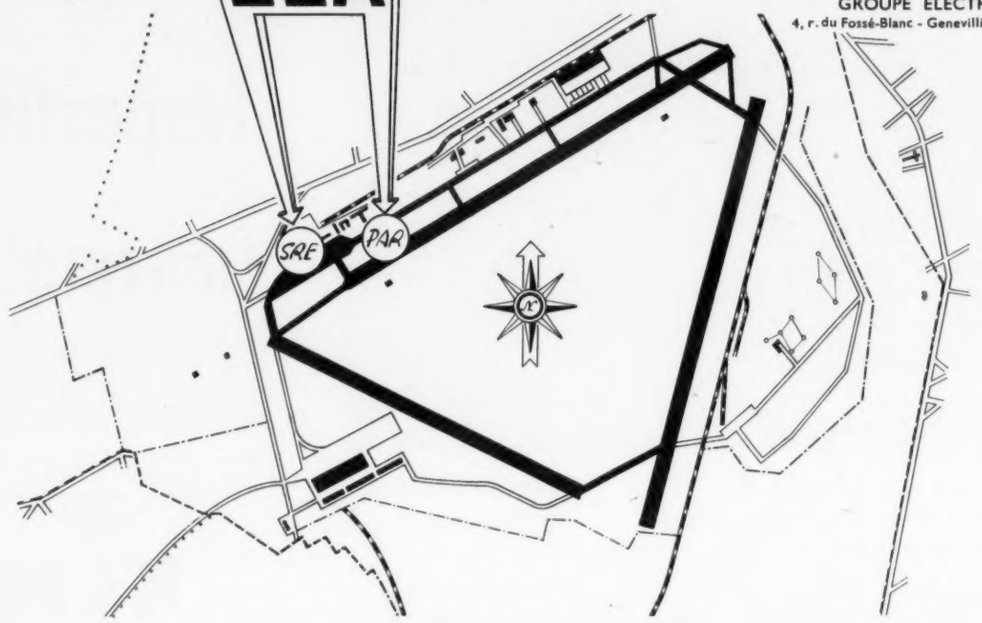

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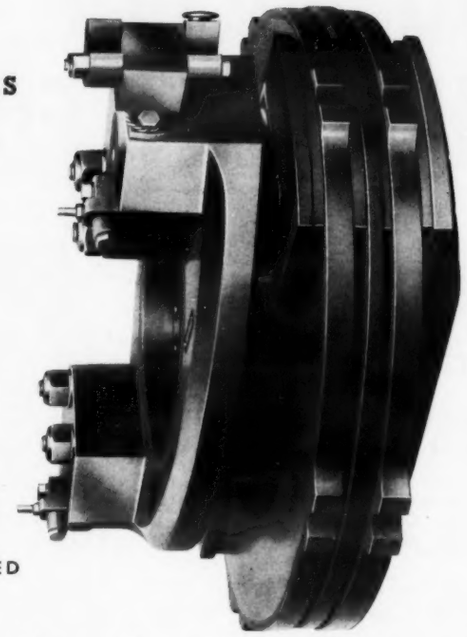

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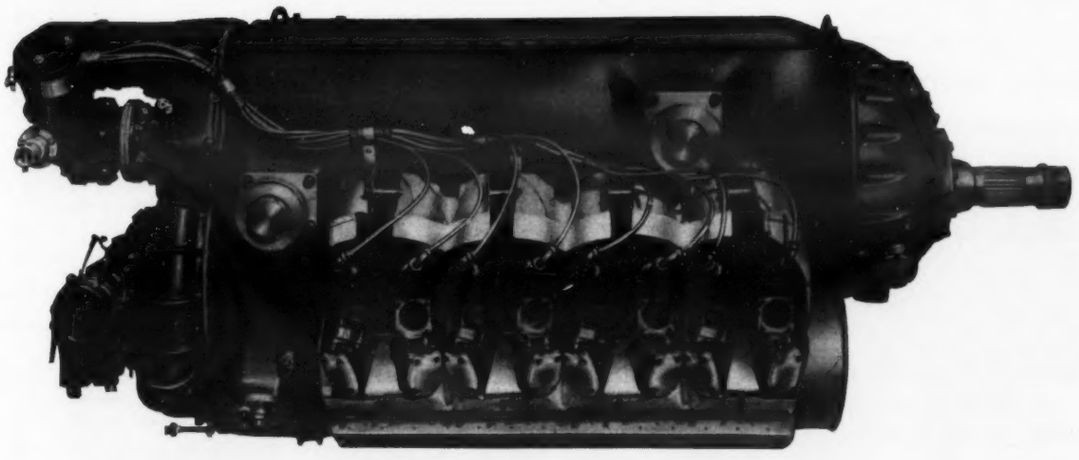

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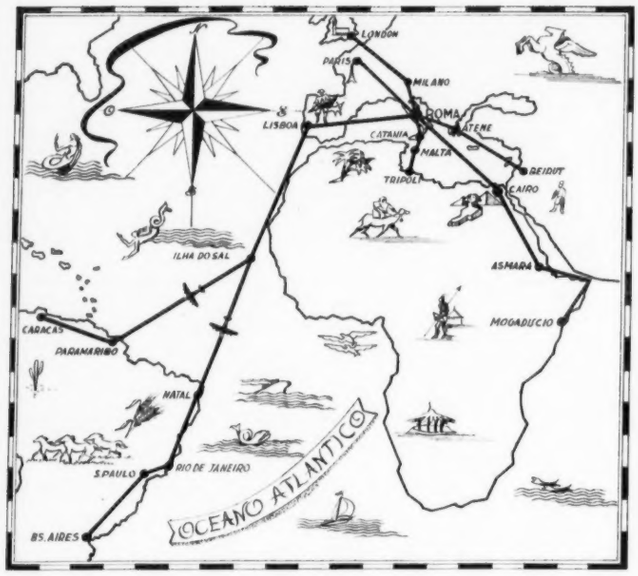

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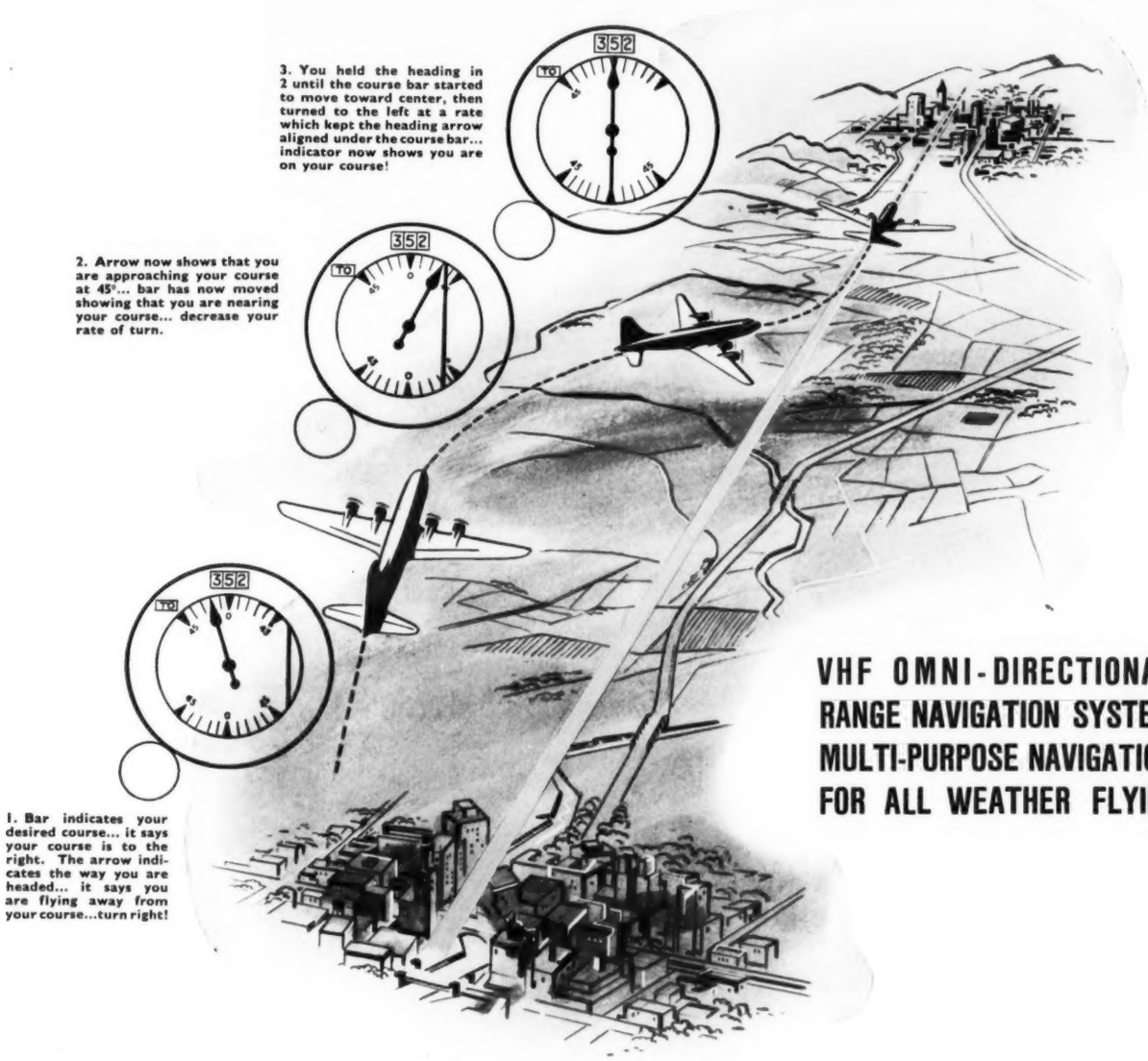
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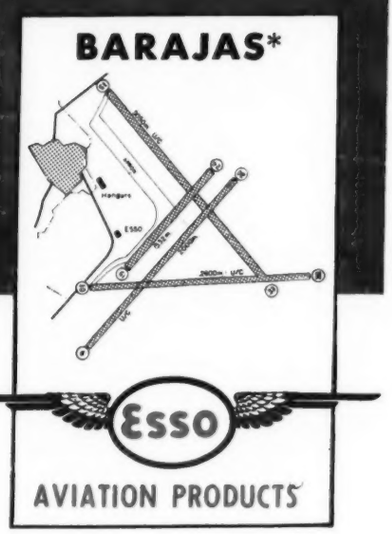

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